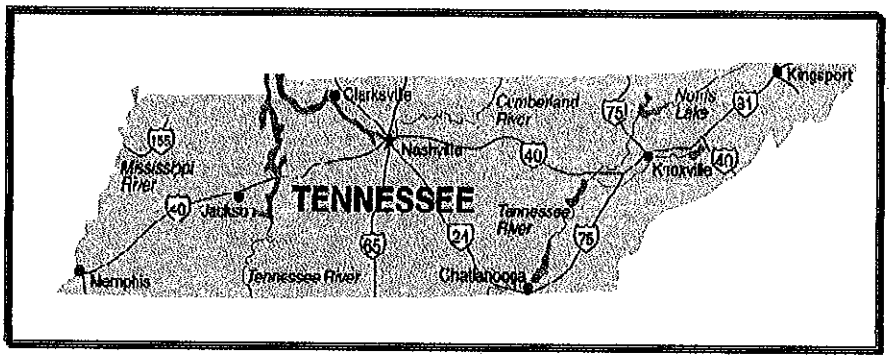
# SOLID WASTE MANAGEMENT IN TENNESSEE

## Diversion of Organic, Construction, and Demolition Material Wastes From Tennessee Class I and Class IV Landfills




Joint Solid Waste Study
Prepared By:

Tennessee State University
Department of Civil and Environmental Engineering

Middle Tennessee State University
Center for Environmental Education

February 15, 2007

## DISCLAIMER

The mention of company/trade names and commercial products does not constitute endorsement or recommendation of use unless explicitly specified.

# Diversion of Organic, Construction, and Demolition Wastes

## Joint Study Work Group Co-Chairs

**Roger Painter, PhD, P.E.**
**Assistant Professor**
**Civil and Environmental Engineering**
**Tennessee State University**

**Cindi Smith-Walters, PhD**
**Professor and CEE Director**
**Biology Department**
**Middle Tennessee State University**

## Work Group Members

| | |
|---|---|
| **Tiffany Hines**<br>**Graduate Student**<br>**Civil and Environmental Engineering**<br>**Tennessee State University** | **Cynthia Allen**<br>**Secretary**<br>**Center for Environmental Education**<br>**Middle Tennessee State University** |
| **Martha Parks**<br>**Administrative Assistant III**<br>**Civil and Environmental Engineering**<br>**Tennessee State University** | **Laura McCall**<br>**Consultant**<br>**Center for Environmental Education**<br>**Middle Tennessee State University** |
| **Valetta Watson**<br>**Adjunct Professor**<br>**Civil and Environmental Engineering**<br>**Tennessee State University** | **Amanda Sherlin**<br>**Executive Assistant**<br>**Center for Environmental Education**<br>**Middle Tennessee State University** |

## Consultants

| | |
|---|---|
| **Valetta Watson**<br>**Watson Environmental Group, Inc.** | **Cindy Black**<br>**Independent Consultant** |

# Diversion of Organic, Construction, and Demolition Wastes

## Table of Contents

# ACKNOWLEDGMENTS

The Tennessee State University work group would like to acknowledge Mr. R.C. Bartlett and Mr. Nick Lytle for their support in developing background information for this study. A special thanks is also extended to Dr. Decatur Rogers, Dean of the College of Engineering, Technology and Computer Science at TSU. Much appreciation is owed to Mr. Bruce Woods for his recommendations and contribution to this report. The Middle Tennessee State University work group extends gratitude and appreciation to Dr. Tom Cheatham, MTSU Dean of Basic and Applied Science, Dr. George Murphy, MTSU Biology Department Chair, as well as Dr. Christopher Crowell, MTSU Office of Sponsored Programs, and Ms. Debbie Rowland, MTSU Biology Department Executive Assistant for their help and support. Tennessee specific figures and data are from the 2005 Tennessee Municipal Solid Waste Planning Region Annual Progress Reports provided by the Division of Solid Waste Management, Solid Waste Assistance Programs, Section of Planning, Reporting and Waste Reduction. Accepted data and percentages on Municipal Solid Waste were provided by the Environmental Protection Agency.

# ACRONYMS

| | |
|---|---|
| ADC | Alternative Daily Cover |
| CCA | Copper Cromated Arsenate |
| C&D | Construction and Demolition |
| CMRA | Construction Materials Recycling Association |
| DDO | Disposal Diversion Ordinances |
| EPA | Environmental Protection Agency |
| FDEP | Florida Department of Environmental Protection |
| LCID | Land Clearing and Inert Debris |
| MSW | Municipal Solid Waste |
| MSWAC | Municipal Solid Waste Advisory Committee |
| MTSU | Middle Tennessee State University |
| RCDD | Recyclable Construction and Demolition Debris |
| RCRA | Resource Conservation and Recovery Act |
| RSM | Recovered Screened Material |
| SWM | Solid Waste Management |
| SWMA | Solid Waste Management Act |
| SWMP | Solid Waste Management Program |
| TDEC | Tennessee Department of Environment and Conservation |
| TSU | Tennessee State University |

# EXECUTIVE SUMMARY

Improved technology, coupled with rising disposal costs, has led many states to consider more effective alternatives to traditional solid waste disposal. Middle Tennessee State University and Tennessee State University, as directed in Senate Bill 3835 and House Bill 3829, have collaborated on a joint study to examine the present state of solid waste in Tennessee. With an emphasis on the role of Class IV Construction and Demolition Waste and Class I Organic Materials Waste, this study will recommend possible actions to minimize the amount of waste disposed in the aforementioned landfills.

The paper begins with an introduction that describes the state of Solid Waste Management in the United States, why it is important, and what challenges and opportunities exist regarding landfills in Tennessee. It then moves to an analysis of construction and demolition waste in Tennessee landfills, and includes recommendation to legislation on ways of handling this waste stream. Following this discussion is a report on the status of organic food and yard wastes in Tennessee landfills along with recommendations. Supplemental information is provided in a number of appendices. To assist the Tennessee legislature on setting priorities for the near future, the paper concludes with recommendations. Key recommendations include the following:

**Research**
It is recommended that the State of Tennessee sanction research to conduct a Tennessee specific Municipal Solid Waste composition and characterization study. Currently, MSW data for the State of Tennessee is generalized and, in some cases, based solely on estimation. Most of the available recycling data is based on national Environmental Protection Agency data, and does not provide an accurate picture of local diversion and recycling statistics. The State of Tennessee should also support additional landfill research; specifically, those efforts aimed at analyzing and monitoring the processes associated with landfill leaching.

**Assessment**
The State of Tennessee should assess its current methods for reporting Municipal Solid Waste diversion and recycling data in both the public and private sectors with an emphasis on standardization and consistency. The State of Tennessee should also investigate the implementation of statewide ordinances to reduce the waste stream of those waste materials that have suitable secondary diversion markets.

**Training**
The State of Tennessee should continue to expand its training activities for state managers and other key personnel. This "top down" approach should emphasize the Reduce-Reuse-Recyle philosophy for waste management.

As the amount of waste produced in the United States continues to rise, the nation is faced with the responsibility of finding new disposal methods to replace, enhance, or supplement present disposal techniques. It will be crucial that Tennessee's approach to leveraging the benefits and assessing the impacts of waste stream diversion processes keeps pace with emerging technology and brings the state to the forefront on issues related to environmental stewardship and responsibility.

# INTRODUCTION

**The State of Solid Waste in the United States**

According to the United States Environmental Protection Agency's Municipal and Industrial Solid Waste Division, *"In the United States, we generated approximately 245.7 million tons of Municipal Solid Waste (MSW) in 2005---**a decrease of 1.6 million tons from 2004.** Excluding composting, the **amount of MSW recycled increased to 58.4 million tons**, an increase of 1.2 million tons from 2004. This is **a 2 percent increase in the tons recycled.** The recovery rate for recycling (including composting) was 32.1 percent in 2005, **up from 31.4 percent in 2004.** The tons recovered for composting rose slightly to 20.6 million tons in 2005, up from 20.5 million tons in 2004"*[1,2]:

- **Yard trimmings** generated 32.1 million tons of MSW; 19.9 million tons were recovered for a 61.9% ratio of recovery/generation; 12.2 million tons were disposed in the landfill for a 38.1% ratio of disposal/generation;
- **Food scraps and other organics** for composting generated 29.2 million tons of MSW; 0.69 million tons were recovered for a 2.4% ratio of recovery/generation; 28.5 million tons were disposed in the landfill for a 97.6% ratio of disposal/generation;
- **Wood waste generated** 13.9 million tons of MSW; 1.31 million tons were recovered for a 9.4% ratio of recovery/generation; 12.5 million tons were disposed in the landfill for a 90.6% ratio of disposal/generation.

**The State of Solid Waste in Tennessee**

In spite of these positive national trends, solid waste management in Tennessee continues to be a challenge due to increasing population, economic growth, consumerism, and endless waste generation. Tennessean's generate 2.24 tons of MSW per person per year[3]. **This is substantially higher than the national average.** According to EPA estimates, in 2005 Tennessee generated over 4 million tons of organic waste alone (food, yard, and wood waste). Less than one fifth of this was composted, recycled or diverted. In 1991, after federal landfill regulations were enacted, the State of Tennessee passed the Solid Waste Management Act (SWMA) of 1991, which established, among other provisions, *"a 25% per capita state waste reduction goal by the year 1995"*. The following timeline summarizes the status of this reduction initiative to date[4,5,6,7]:

1991: SWMA mandates a 25% per capita state waste reduction goal by 1995.

1995: **TENNESSEE FAILS TO MEET THE 25% REDUCTION GOAL.**

1996: SWMA amended; it is clarified that the diversion of wastes to Class III/IV landfills counted toward solid waste reductions; **25% REDUCTION RATE NOT MET.**

1999: SWMA again amended; waste reduction calculations allowed on an economic growth basis; 1995 established as the new base year; December 31, 2003 set as new date for achieving 25% waste reduction.

2003: **TN AGAIN UNSUCCESSFUL IN MEETING 25% REDUCTION.**

2004: SWMA reauthorized; 75 cent tipping fee surcharge implemented and regional 10 year plans allowed revision to reflect regional developments.

2007: **THE 25% WASTE REDUCTION GOAL HAS YET TO BE MET.**

Possible reasons for continued failure to meet the 25% reduction goal are as follows:

- a lack of markets of recycled and/or composted solid waste;
- inconsistent solid waste reporting methods in Tennessee;
- a scarcity of government programs that encourage source reduction and/or recycling; and
- differences between Tennessee's and EPA's list of materials 'counted' as landfill in MSW.

The Tennessee average is also somewhat inflated as a result of the ten counties listed in Table 1 who: a) collectively account for 65% of all Tennessee MSW disposed, b) have a per capita disposal rate over three times the national average, c) have a per capita disposal rate twice the state average, and d) host 50% of the population while disposing of only 65% of the waste.

| Tennessee County | Tons Disposal Disposal | 2005 Population | Disposal (tons/Capita) |
|---|---|---|---|
| Shelby | 1,490,424 | 909,035 | 1.64 |
| Davidson | 839,779 | 575,261 | 1.46 |
| Hamilton | 471,687 | 310,935 | 1.52 |
| Knox | 470,510 | 404,972 | 1.16 |
| Rutherford | 269,898 | 218,292 | 1.24 |
| Sullivan | 191,394 | 152,716 | 1.25 |
| Maury | 178,388 | 76,292 | 2.34 |
| Bradley | 168,394 | 92,092 | 1.83 |
| Williamson | 151,681 | 153,595 | 0.99 |
| Washington | 139,954 | 112,507 | 1.24 |
| **10 County Total:** | **4,372,109** | **3,005,697** | **1.45** |
| **Tennessee Total:** | 6,685,136 | 5,962,959 | 1.12 |
| **U.S. Total:** | **133,300,000** | **296,410,000** | **0.45** |

**Table 1**: "Top 10" municipal solid waste generator counties in Tennessee. In 2005, over 13 million tons of municipal solid waste was generated in Tennessee. Nearly 6.7 million tons were recycled, reused, or reported diverted from Class I landfills. The remaining municipal wastes were disposed in 36 permitted Class I (sanitary) landfills. Even modest decreases in disposal rated by the Top 10 would have substantial impact on the MSW stream, Tennessee's landfills, and the environment.[8,9,10,11]

## *"One Man's Trash, Is Another Man's Treasure"*

This familiar proverb truly applies to the current state of solid waste in Tennessee. Are there logical, cost effective, and socially responsible ways to reduce the mountains of trash currently being stockpiled daily? What if a good deal of Tennessee's solid waste could be diverted from landfills? What if there were markets where indeed one man's trash could be converted, through recycling, composting, or other methods of diversion, into another man's treasure?

**Scope of Study**

As directed in Senate Bill 3835 and House Bill 3829, the Middle Tennessee State University (MTSU) Center for Environmental Education, in conjunction with the Tennessee State University (TSU) Department of Civil and Environmental Engineering, has investigated the current state of Class I and Class IV landfills in Tennessee with in emphasis on the **diversion of organic, construction, and demolition wastes** from these facilities. According to the Tennessee Department of Environment and Conservation (TDEC), Class I landfills are defined as "sanitary landfills serving municipal, institutional, and/or rural populations and used for disposal of domestic, commercial and institutional wastes, including municipal sold waste, bulky wastes, landscaping and land clearing wastes, industrial and farming wastes, dead animals, and other special wastes[12]". In fiscal year 2004-2005, there were 36 permitted Class I landfills in Tennessee, nineteen of which were publicly owned[13]. Class IV landfills are "construction and demolition (C&D) landfills used for the disposal of C&D wastes, shredded automotive tires, and wastes with similar characteristics as approved in writing by the department[14]". In fiscal year 2004-2005, there were 72 Class III and IV landfills in 61 counties throughout Tennessee, 44 of which were owned by local counties[15].

**Organic materials** make up a significant amount of waste generation and disposal in Tennessee. Reducing, reusing, recycling, and composting organic materials will aid local governments in reducing the amount of waste disposal in Class I and Class IV landfills[16]. Based on EPA percentages of waste disposal, 33% of the waste disposed in landfills is comprised of organic material. Communities with existing organic recycling programs will be able to increase their waste diversion rates by adding additional organic programs[17]. Communities without existing organic recycling programs will be able to increase their waste diversion rates by building infrastructure, establishing markets, and implementing organic recycling programs.

**Construction and Demolition** waste has been called the hidden or forgotten waste stream[18]. Only in recent years has C&D waste begun to garner public and government notice. C&D waste has not received the level of public attention as MSW, and many states including Tennessee have not adequately studied or tracked the C&D portion of their solid waste stream. Consequently, even as municipalities and states begin to enact some form of C&D legislation, questions persist about the size of the markets for recycled commodities, the number of players, and the potential for financial gain and material recovery.

**The primary objectives of this study are to**:

- Examine the status of construction, demolition, food and yard wastes generated in our state.
- Highlight our biggest county and municipal producers of solid waste.

- Review what is being done locally, statewide, and nationally to deal with these problems.
- Offer general recommendations regarding possible solutions to the issue.

**The analysis and conclusions in this joint study are based on:**

- The research conducted by MTSU on food, yard, and wood waste found in Class I landfills.
- The research conducted by TSU on C&D waste found in Class IV landfills.
- Review of Tennessee solid waste legislation.
- Review of prior studies on reducing solid waste in Tennessee.
- Review of materials produced by TDEC Division of Solid Waste Assistance.
- Review of Solid Waste Annual Planning Reports submitted to TDEC by County and Development Planning districts.
- Attendance at meetings of the Municipal Solid Waste Advisory Committee (MSWAC).
- Interviews with state, county, and local solid waste officials.
- Interviews with nationwide solid waste officials.
- Interviews with commercial organic waste generators and processors in Tennessee and across the United States.
- Interviews with food recovery and food rescue affiliates.
- Site visits to composting/mulching facilities in Tennessee.
- Web-based research on organic and C&D waste streams.
- Review of case studies on organic programs and composting in Tennessee and the US.
- Interviews with demolition/construction contractors.
- Review of census data regarding population, demographics and economic data.

# CONSTRUCTION AND DEMOLITION WASTE ANALYSIS

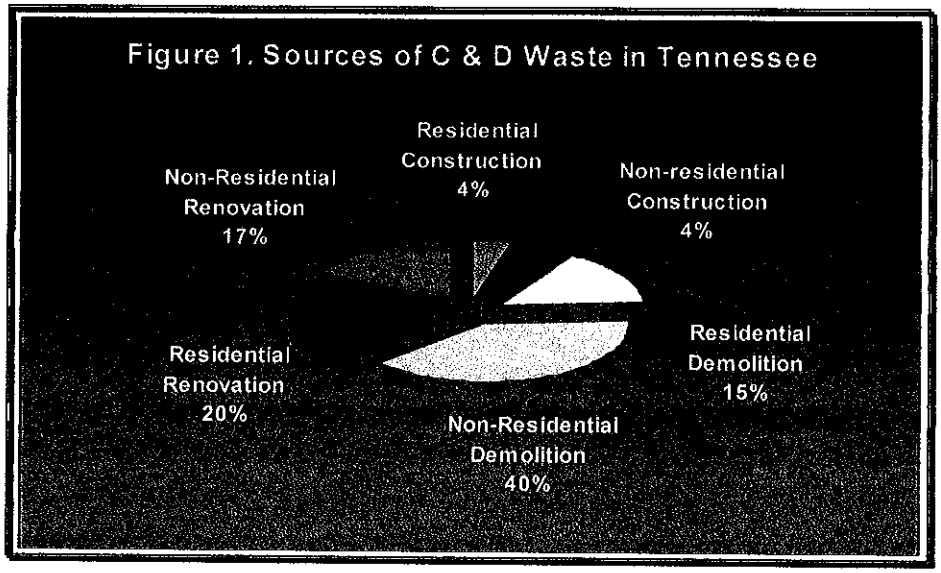
**C&D Waste Generated in Tennessee**

Construction and demolition (C&D) waste is defined as waste or debris resulting from construction, remodeling, repair, and demolition of homes, commercial buildings and other structures and pavements. Construction, renovation, and demolition jobs produce varying quantities of the following materials[19]:

- Wood (clean scrap lumber),
- Brick and block (aggregates),
- Wood (painted or treated),
- Gypsum wallboard,
- Manufactured wood (plywood, etc.),
- Cardboard,
- Miscellaneous fines,
- Asphalt shingles (scrap or tear-off),
- Metals (pipes, wire, conduits, structural beams, etc.),
- Asphalt pavement,
- Miscellaneous plastics (PVC, HDPE, etc.),
- Land clearing debris,
- Concrete (with and without re-bar), and
- Salvageable materials (i.e., windows, doors, fixtures, etc).

Approximately 2.6 million tons of building-related C&D waste was generated in Tennessee during 2005. This represents approximately 25 percent of Tennessee's total solid waste stream[20]. Figure 1 shows the major sources of construction and demolition waste in Tennessee. A majority of that material was disposed in construction and demolition (Class III/IV) landfills, municipal solid waste (Class I) landfills, and land clearing and inert debris (LCID) landfills. Because of difficulty in accurately determining the amount of C&D wastes entering these disposal facilities, other methods were used to estimate generation. The reported recovery by recycling facilities for 2005 was approximately 45,000 tons, or roughly two percent of the C&D waste stream.

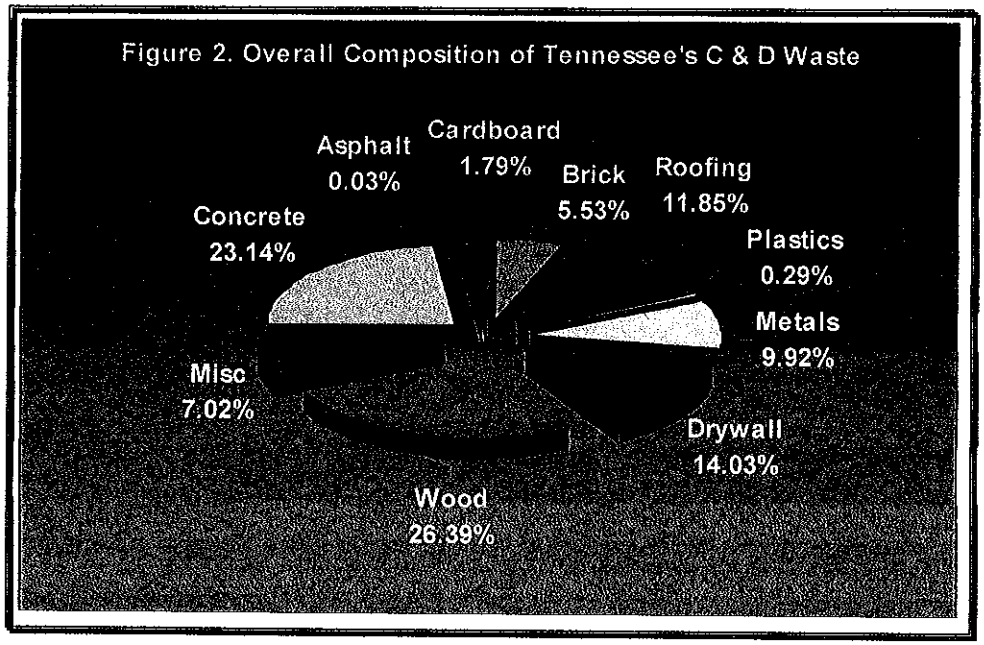
The composition of C&D waste varies with the type of structure and specific C&D activities. However, the waste stream can be characterized in a general sense[21]. Table 2 provides an overall estimate for C&D waste generated in Tennessee during 2005, and Figures 1 and 2 provide characterizations of C&D waste by source and waste stream components. About 60 percent of all C&D waste generated in Tennessee in 2005 was from non-residential sources. Waste from non-residential sources can be further broken down as 7 percent construction, 29 percent renovation, and 64 percent demolition. Residential sources generate the remaining 40 percent of C&D waste. The makeup of the residential portion was 11 percent from construction, 50 percent from renovation and 39 percent from demolition.

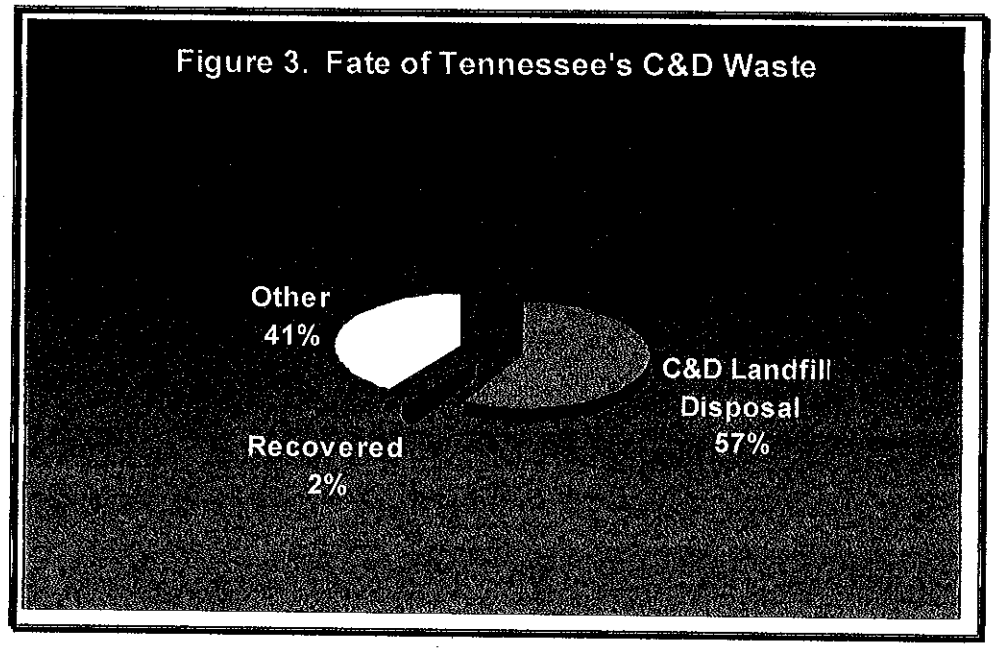



TDEC reported that approximately 1.5 million tons of C&D waste was disposed in Tennessee's Class III/IV landfills in 2005[22]. The disposal rate provided by TDEC is an approximation because many C&D landfills in Tennessee do not have scales and the tonnage reported to TDEC is subject to errors associated with volume to tonnage estimates by the facilities. Based on a generation rate of 2.6 million tons, this indicates that Tennessee disposed almost 60 percent of C&D waste generated in 2005 in Class III/IV landfills. Limited infrastructure exists for C&D recycling in Tennessee, and only about 45,000 tons were reported recovered during 2005, or roughly 2 percent of the C&D waste stream. Readers should note this is reported recovery and that there is a significant amount of unreported C&D waste recovery by small unlicensed operations.

| **Residential** | **Total** | **1,026,663** |
|---|---|---|
| Construction | 110,595 | (10.8 %) |
| Renovation | 516,000 | (50.3%) |
| Demolition | 400,068 | (38.9 %) |
| **Non-Residential** | **Total** | **1,571,795** |
| Construction | 109,462 | (7.0 %) |
| Renovation | 453,250 | (28.8 %) |
| Demolition | 1,009,083 | (64.2 %) |
| **Total All Sources:** | | **2,598,458** |

**Table 2**: Total generation of construction and demolition waste in Tennessee for the year 2005 (tons).




As shown in Figure 3, roughly 40 percent of Tennessee's C&D waste generation for 2005 is not accounted for by Class III/IV disposal and recovery. Data is not available to determine the specifics regarding the fate of this fraction (approximately 1 million tons in 2005) of the waste stream but the major modes of disposal are likely Class I landfill disposal, LCID landfill disposal, open burning and onsite disposal.

It is likely that some amount of wood from C&D waste is being processed along with materials such as trees and brush, resulting from land clearing activities. These types of material typically are made into mulch or compost products. However, the amount of C&D wood that ends up mixed with land clearing debris is not known and is not included in recovery. It is also likely that a significant amount of the approximately 260,000 tons of metals generated with C&D waste

was recovered due to the relatively higher market value of metals. Here again there is no data regarding the amount of these metals being recovered.

Unlike MSW there is little hard data regarding the rate of generation of construction and demolition waste in Tennessee. This section represents an overview of the calculations, assumptions, and data sources used to estimate the generation of C&D waste in Tennessee during 2005. The estimations are based on current cost factors, engineering parameters and other census and economic information. The estimates can be updated annually. There are two major categories for C&D debris: residential and non-residential. Each category is further divided into three sub categories: construction, demolition, and renovation. Certain materials were omitted from this report. For example, waste generated by public utilities and military facilities was omitted because of a lack of available data. Land clearing waste associated with the activities below was also omitted because of the wide range of management options available (i.e., open burning, LCID landfills, etc.)[23,24,25,26,27].

**Annual residential construction waste generation in Tennessee**: An estimate of the annual residential construction waste generation was obtained based on the total value of residential construction put in place in Tennessee according the 2002 Economic Census conducted by the U.S. Census Bureau. This value was inflated to 2005 dollars and an average cost per square foot of residential construction was used to calculate the total square footage of residential construction in Tennessee during 2005. An annual inflation rate of 3.0% was used for all C & D waste generation calculations presented in this report. Tons of residential construction waste generated was then obtained based on the average waste generation rate (pounds per square foot) from Franklin and Associates, 1998. This resulted in an annual residential construction waste generation for Tennessee of 110,595 (tons/year).

$$W = \left(\frac{A}{B}\right)\frac{C}{2000}$$

where:

W = Amount of waste generated

A = Total annual value of residential construction work in Tennessee (U.S. Census Bureau, 2002, inflated to 2005 dollars. $3,487,537,000)

B = Average price per square foot for residential construction in the South ( "Generation and Composition of Construction and Demolition Debris in Florida", 2002, inflated to 2005 dollars; $69.06/ $ft^2$)

C = Waste generation (lb/sq ft) from residential construction (Franklin and Associates, 1998; 4.38 lb/ $ft^2$)

**Annual non-residential construction waste generation in Tennessee**: The method for estimation of the non-residential construction waste generation is analogous to the method above for residential construction waste generation. The total value of non-residential construction put

in place in Tennessee and an average cost per square foot for non-residential construction resulted in an annual non-residential construction waste generation for Tennessee of 109,462 (tons/year).

$$W = \left(\frac{A}{B}\right)\frac{C}{2000}$$

where:

W = Amount of waste generated

A = Total annual value of non-residential construction work in Tennessee (U.S. Census Bureau, 2002, inflated to 2005 dollars. $5,878,627,582)

B = Average price per square foot for residential construction in the South (Franklin and Associates, 1998, inflated to 2005 dollars; $107.95/ ft$^2$)

C = Waste generation (lb/sq ft) from non-residential construction (Franklin and Associates, 1998; 4.02 lb/ ft$^2$)

**Annual residential demolition waste generation in Tennessee**: The method used to estimate the annual waste generated from residential demolitions in Tennessee was adapted from a method used by the state of Florida in a 2002 study. The method is similar to the method used by EPA for the national estimate. A value of the total amount spent on demolitions in the state was found in the 2002 U.S. Bureau of the Census report, "Construction – Geographic Area Series." This value was multiplied by the percentage of demolitions that are residential demolitions (by cost) to get a cost of residential demolitions in Tennessee. A problem arises using the total value of demolitions because data is not available for the ratio of residential to nonresidential demolition in Tennessee. In view of this constraint, it was assumed that the percentage of Tennessee's total demolition value associated with residential demolition is similar to that for the state of Florida. The percentage of residential demolition (28%) of the total demolitions in Florida was derived from a survey of demolition contractors in Florida (Cochran, 2001). The value of demolition work was divided by the price per square foot to get an estimate of total area of demolitions. The average price per square foot of residential demolition work was derived from EPA's 1998 study and inflated to 2005 dollars.

The fact that there is no quantitative data specifically for the ratio of residential to nonresidential demolition work in Tennessee impacts the characterization of Tennessee's total C&D waste stream; however, the combined total waste generation is not sensitive to this ratio if a weighted average cost is used with the total value of demolition work in Tennessee.

$$W = \left(\frac{Ax}{B}\right)\left(\frac{Cy + Dz}{2000}\right)$$

where:

W = Amount of waste generated (tons)

A = Total value of all demolition work (residential and non residential) in Tennessee (U.S. Census Bureau, 2002 inflated to 2005 dollars; $47,038,973)

x = Fraction (based on cost) of all demolitions that are residential in Tennessee (demolition contractor survey; 0.28)

B = Average cost per square foot for residential demolition (derived from national data, Franklin and Associates, 1998 and Total value of all demolition for U.S. Inflated to 2005 dollars; $1.94/ft$^2$)

C = Waste generation rate (pounds per square foot) for single-family house (Franklin and Associates, 1998; 111.30 lb/ ft$^2$)

y = Fraction of units demolished that are single-family houses (Franklin and Associates, 1998; .66)

D = Waste generation rate (pounds per square foot) for multi-family building (Franklin and Associates; 127 lb/ ft$^2$)

z = Fraction of units demolished that are multi-family buildings (Franklin and Associates, 1998; .34)

**Annual non-residential demolition waste generation in Tennessee**: The method for estimation of the non-residential construction waste generation is analogous to the aforementioned method for residential demolition waste generation.

$$W = \left(\frac{Ax}{B}\right)\frac{C}{2000}$$

where:

W = Amount of waste generated (tons)

A = Total value of all demolition work (residential and non residential) in Tennessee (U.S. Census Bureau, 1997 inflated to 2005 dollars; $47,038,973)

x = Fraction (based on cost) of all demolitions that are non-residential in Tennessee (demolition contractor survey; 0.72)

B = Average cost per square foot for non-residential demolition (derived from national data, Franklin and Associates, 1998 and Total value of all demolition for U.S. Inflated to 2005 dollars; $2.92/ft$^2$)

C = Waste generation rate (pounds per square foot) for non-residential demolition (Franklin and Associates, 1998; 174.00 lb/ ft$^2$)

**Annual residential renovation waste generation in Tennessee**: Waste generated from the renovation of residential and non-residential buildings is difficult to estimate. For purposes of this report, renovation waste is defined as waste generated from the renovation, improvement or repair of structures. Renovations vary greatly in size, cost, and waste generated. Do-it-yourself projects and the small scale of some improvements, makes it difficult to track renovations through permitting records. In view of these constraints, Tennessee's renovation waste generation was estimated in a fashion similar to that used by EPA. A conversion factor of 0.56 pounds of waste generated per dollar of renovation value was developed. This conversion is derived from EPA's estimate of total waste generated from residential renovations in 1996 and the total value of these renovations in 1996 dollars.

The conversion factor was adjusted for inflation to 2005 dollars (0.43 pounds per 2005 dollar) and the total value of residential improvements for 2005 from the census bureau was extrapolated by population to give a total value of residential improvements of approximately $2.4 Billion for Tennessee in 2005. This resulted in an estimate for residential renovation waste generation in 2005 of 516,000 tons per year.

$$W = \left(\frac{A\,B}{2000}\right)$$

where:

W = Amount of waste generated

A = Total annual value of residential renovation work in Tennessee (U.S. Department of Commerce," Expenditures for Residential Improvements and Repairs". 2005; $2,400,000,000 in 2005 dollars)

B = Average pounds of renovation produced per dollar of renovation expenditures (Franklin and Associates, 1998; in 1996 dollars;0.56lb/$, 0.43 lb/$ in 2005 dollars)

**Annual non-residential renovation waste generation in Tennessee**: Waste assessments were not available for nonresidential renovation. Therefore, the methodology used for residential renovation cannot be used to estimate nonresidential renovation waste generation. Lacking specific assessment data, it was assumed that the amount of waste produced is proportional to the ratio of dollars spent on the two sectors and that the ratio (roughly one to one) has not changed significantly since the 1998 EPA study. This resulted in an estimate for nonresidential renovation waste generation in 2005 of 453,250 tons per year.

$$W = \left(\frac{AC}{B}\right)\frac{D}{2000}$$

where:

W = Amount of waste generated

A = Total annual value of non-residential renovation work in the U.S.

(Franklin and Associates, 1998; $100,400, 000,000 in 1996 dollars)

B = Total annual value of residential renovation work in the U.S
(Franklin and Associates, 1998; $114,300, 000,000 in 1996 dollars)

C = Total annual value of residential renovation work in Tennessee
(U.S. Department of Commerce," Expenditures for Residential Improvements and Repairs". 1998; $2,400,000,000 in 2005 dollars)

D = Average pounds of renovation produced per dollar of renovation expenditures
(Franklin and Associates, 1998; in 1996 dollars; 0.56lb/$, in 2005 dollars 0.43 lb/$)

**C&D Waste Generation Methodology**

Estimates for Tennessee's C&D waste generation and its characterization presented in previous sections represent a snapshot of Tennessee's C&D waste stream for 2005. However, the methodology incorporates cost factors, Census Bureau, and various economic indicators allowing the estimates to be updated annually. These estimation methods are currently the best available given the lack of C&D generation data on a county or jurisdiction level. It is recommended that the generation rates for 2006 and 2007 be estimated when the 2007 Census Bureau Economic Reports are released later this year.

This report characterizes the overall C&D waste stream in Tennessee but the analysis and recommendations for recovery efforts apply only to the building related C&D waste stream. Limited data is available on the total generation of road construction related waste. Thus, it could not be added to the generation figures for building-related C&D waste, although it is likely a large component of the overall C&D waste stream. Aside from lack of data, the overriding reason for excluding road construction waste from the analysis is because most of the recoverable portion of road waste is already being recovered. Most concrete is left untouched when repairing highways. Top layers of asphalt are milled or scraped off roads, then either directly reapplied or transported to an asphalt plant to be reprocessed. The remainder of this waste is largely made up of concrete ruble and various aggregate materials which is also used extensively on road jobs because it is more cost effective than bringing in virgin materials. Land clearing waste is also excluded from this report.

Waste reduction data is a universal challenge for those in solid waste management. "Other states and the EPA have been unable to find an ideal way of ensuring good waste reduction data"[28]. Previous reports presented to the Governor of Tennessee by the Comptroller of the Treasury's Office of Research have recognized this challenge.

- *The waste reduction calculations for regions may not be accurate in all cases.* (Tennessee's Trash in the 1990's, an update, July 1998)
- *Local governments collect solid waste data inconsistently from county to county.* (Tennessee's Trash in a New Century, June 2004)

Tennessee Department of Environment and Conservation, through the Division of Community Assistance and Solid Waste Management, continues to seek and implement new technologies which will aid Planning Regions and Counties in providing more accurate and consistent data on their Annual Progress Reports. Under-reporting and over-reporting often occur due to methods of data collection. While data collection from Class I landfills is readily available, waste

reduction and diversion numbers from private industry are inconsistent. Uniform standards and emphasis on collecting industry data will offer a more realistic picture of the state of solid waste in Tennessee. Figures and data used in this study were taken from the 2005 MSW Planning Region Annual Progress Reports provided by the Division of solid Waste Management, Solid Waste Assistance Programs, Section of Planning, Reporting and Waste Reduction.

**Markets for Commodities from C&D Waste**

Successful identification and development of markets for commodities from recycled C&D waste is an important element to increasing the amount of C&D waste recovery in Tennessee. However, these market forces alone will not result in significant improvement in the face of cheap land, low tipping fees and unlimited availability of landfill volume. Some of the main commodities from C&D waste are briefly described below.

**Metals**: Metals comprise approximately **10 percent** of Tennessee's C&D waste stream. Source-separated metals from construction or demolition debris are typically the highest value materials, and are more commonly recovered than disposed. Aluminum, steel, and copper are the most common metals found in C&D debris. These materials are typically accepted at all salvage yards directly from the contractor. If large enough volumes are being generated at a job site, metal recyclers will sometimes site containers for free, or at a minimal cost to cover transportation.

**Asphalt Shingles**: Asphalt shingles make up approximately **12 percent** of Tennessee's total C&D waste stream. Some scrap asphalt shingles from the manufacturing process and from new construction currently are being recovered. However, shingles from roof replacements (tear-off shingles) are not being recovered because some shingles previously were made with asbestos. Until a cost-effective means for testing tear-off shingles for asbestos is developed, they will continue to be disposed of in landfills. A potentially large market exists for asphalt shingles as an additive to asphalt pavement. Asphalt shingle scrap, along with other tar-based materials (such as tarpaper and flat roof asphalt aggregate), can be processed into road paving mix. Scrap must first be ground and nails and ferrous metals removed with a magnet before being mixed with recovered asphalt and primary materials for new paving mixes. The fiberglass component of shingles can have a beneficial effect in making the mix more durable or water repellent.

**Drywall**: Drywall, also referred to as sheetrock and wallboard, makes up an estimated **14 percent** of the C&D waste stream. Scrap drywall from the manufacturing process and from new residential, including the manufactured housing industry, and commercial construction currently are being recovered. However, drywall from renovations or demolition is not typically considered to be recyclable since most of the material is painted or treated. Drywall is composed primarily of gypsum or calcium sulfate and a paper backing. As a pH neutral and absorbent material, recovered gypsum may be used for applications such as cat litter and as a spill absorbent product. Gypsum also is used in agricultural applications in North Carolina as a soil amendment. Gypsum adds calcium, sulfur, and some boron to the soil, is pH neutral, and loosens clay soils.

**Wood**: Wood makes up approximately **26 percent** of the C&D waste stream. Clean wood waste from construction sites has many uses with the most valuable being re-use. However, dimensional lumber scrap (i.e., 2 X 4's) may not be acceptable for structural purposes unless the

grade stamp is visible. The industry in the United States is considering certification methods for grading used lumber. Clean dimensional lumber scrap can be finger-jointed into longer pieces. Finger-jointed lumber is generally straighter than ordinary two-by-fours and is approved for structural use. Clean dimensional lumber scrap also can be made into mulch or used as a component of compost. The price paid for a ton of clean dimensional lumber will vary based on the size of the load and the distance to the processing facility. Most mulch facilities have the ability to chip or grind lumber, but the price paid for mulch ranges from free to $2.50 per ton in the United States. Wood waste from demolition sites is more likely to contain paint or other contaminants. For this reason, it is not generally usable as soil amendment, but may be used as fuel depending on the level of contamination.

**Concrete**: Concrete makes up approximately **23 percent** of Tennessee's total C&D waste stream. Concrete can be ground into a relatively high quality aggregate or gravel substitute for use as a road base material. Gravel for use in road construction ranges from approximately $8 to $15 per ton delivered to the site. Prospects are poor for a significant demand in Tennessee for aggregate from recycled concrete because of the state's abundant supply of limestone aggregate.

**Long Term Potential for C&D Recovery in Tennessee**

A survey of members of the Construction Materials Recycling Association (CMRA) found that only a "couple" (exact number is unknown) hundred mechanized mixed C&D waste processing facilities exist in the U.S. An average mixed C&D plant has a throughput of 110,500 tons per year, of which 78,000 tons per year, or 71 percent, were recycled. This figure includes C&D waste used as Alternative Daily Cover (ADC) at landfills.

Nationally, concrete/asphalt and wood made up the largest shares of materials recycled, comprising 20 to 25 percent of the total waste stream respectively. Gypsum, metals, asphalt shingles, and all other materials ran in the single digits, while ADC totaled about 17.1 percent of the C&D waste stream. For concrete and waste wood plants, the figures were considerably higher. The CMRA members surveyed recorded an average concrete throughput of 150,000 tons per year, of which 149,000 were recycled. Wood was processed at an average of 37,000 tons per year, of which 36,500 was recycled in some fashion.

According to TDEC officials, Tennessee currently has only one mechanized mixed waste processing facility in Williamson County. The C&D program at Williamson County generates materials that are used for various landfill programs, including erosion control and vegetative purposes. Lewis Bumpus, solid waste director for the county, believes that the counties mixed waste processing facility will extend the life of its C&D landfill by 30 years. This operation should serve as a model for other jurisdictions in Tennessee and provide valuable guidance for entrepreneurs interested in providing C&D waste processing services.

Some inference can be made regarding the nature of Tennessee's C&D recovery as recovery facilities eventually replace land disposal facilities. If all of the 1.5 million tons of C&D waste disposed in Class III/IV landfills in 2005 had passed through mixed C&D waste processing facilities similar to the Williamson county facility and the residuals then land disposed; approximately 1.0 million tons of materials would have been recovered and only 0.5 million tons disposed in Class III/IV landfills. Based on the typical size of these recovery operations,

Tennessee could accommodate 10 to 20 facilities statewide located in densely populated areas, and regional facilities in the more rural areas of the state. In coming years C&D processing facilities with adjacent Class III/IV landfills will replace purely land disposal facilities and the unreasonable act of disposing C&D waste in our Class I landfills will cease. In the interim there will be significant resistance from the solid waste industry who will prefer, at least in the short term, to bury these valuable commodities in Tennessee's abundant and relatively inexpensive landfills.

**Problems With Disposal And Recovery Of C&D Waste**

As a whole, construction and demolition wastes are generally considered to be composed of inert material that will not leach into the groundwater. In the past, this has resulted in far less regulation in terms of disposal and monitoring of environmental impacts (i.e., groundwater contamination). C&D waste does however have the potential to impact groundwater. This impact can be classified as one of two types. The first category is contamination with trace amount of hazardous chemicals, primarily organic compounds or heavy metals. These chemicals are believed to be the result of small amounts of hazardous chemicals either applied to the construction materials, or by the improper disposal of residue or bulk chemicals in the C&D waste stream. A second type of contamination results from larger amounts of generally nontoxic chemicals that can result in the degradation of groundwater quality. These chemicals, such as chloride, sodium, sulfate, and ammonia, may be attributed to the leaching of primary C&D waste materials. It should be noted that these materials do not always result in the exceedance of primary drinking water standards; however, they may exceed some secondary standards for taste, odor, and aesthetics.

Because of growing awareness that C&D debris can contain hazardous materials such as lead-based paint, asbestos, or wood coated with copper chromated arsenate (CCA), some states are in the process of revising their C&D debris regulations. These states include California, Colorado, Kansas, Massachusetts, North Carolina, Ohio, South Carolina, and Washington. In the State of Massachusetts, concrete, asphalt, brick, wood, and cardboard were banned from landfills at the end of 2003 although implementation has been delayed (Clark, et. al., 2004:13). California is developing regulations for recycling facilities that would require mixed C&D debris recycling facilities that accept more than 175 tons per day (recycling at least 60% of that) in order to obtain a solid waste permit (Clark, et. al., 2004:14). Increased regulation can cause C&D tipping fees to rise, which can result in increased C&D recycling (Clark, et. al., 2004:13-14).

While C&D waste recycling has resulted in less material being buried, other environmental concerns have been encountered. In the C&D recycling process, a number of separation technologies are used, including screening and size reduction. The fraction that passes the screens is, mostly made up of soil and small aggregates, fines are derived from screening C&D debris. The quality of the resulting product is related to the materials from which the debris was originally screened, and has been termed recovered screened material (RSM). It offers the potential to be used as fill material for roadways, embankments, or other construction projects. The use of RSM has been impeded by the presence of trace amounts of heavy metals, particularly arsenic. Arsenic concentrations have been encountered at levels high enough to limit reuse options for RSM.

Another problem associated with the disposal and recovery of construction and demolition waste is purely one of economics. The supply of C&D waste in Tennessee dwarfs the current demand from C&D recovery facilities. C&D waste recycling is based on cost-avoidance (i.e., a reduced tipping fee) and not revenue generation. Thus, the quantity of C&D waste recovered is directly related to the cost of disposal. In areas of the country where landfill tipping fees are significantly higher, more material is being diverted. However, in Tennessee where tipping fees are relatively low, there is little incentive for C&D recycling. Figure 4 compares the tipping fees for several southern states[29].

**Southeastern U.S. Landfill Tipping Fees**

| State | Average Cost per Ton |
|---|---|
| Alabama | $27.01 |
| Arkansas | $28.01 |
| Florida | $36.42 |
| Georgia | $33.07 |
| Kentucky | $32.87 |
| Louisiana | $26.65 |
| Mississippi | $26.81 |
| North Carolina | $32.80 |
| South Carolina | $34.22 |
| Tennessee | $28.96 |
| Virginia | $39.99 |
| West Virginia | $35.44 |
| Southeastern Total | $33.43 |

Source: Waste News 2005 Market Handbook

**Figure 4**: Comparison of tipping fees for several southern states. Tennessee's fees are relatively low.

A majority of C&D waste continues to be disposed in Tennessee's relatively inexpensive landfills. The Comptroller's Office of Research listed diversion of C&D waste as a concern in the 1998 report, *Tennessee's Trash in the 1990s, an update*[30]. This concern stems from a 1996 amendment to the Solid Waste Act of 1991 that allows jurisdictions to count C&D waste diverted from its Class I landfills to Class III/IV landfills toward reduction goals for MSW. Some argue that diverted waste should not count as a reduction because it is still disposed of in landfills. Further, Class III/IV facilities are not regulated as stringently as Class I facilities, creating the potential for dumping materials, such as toxic or hazardous substances, that could be problematic in the future. Class III/IV facilities are not required to have a liner, required in Class I facilities to prevent leachate from the landfill from filtering through the ground and potentially contaminating groundwater. One group reported that approximately 0.5 to 1 percent of the total waste stream, including that waste entering Class III/IV facilities, is composed of toxic substances that can contaminate groundwater. Aside from ones position on these concerns it is

clear that counting diversion of C&D waste toward reduction is at least partially responsible for the poor job Tennessee is doing in its effort to recycle C&D waste.

## Recommendations for C&D Waste Stream

In addition to providing Tennessee legislature with an analysis of the current status of Tennessee's C&D waste stream, an additional goal of this study was to provide general recommendations were legislative action can positively impact C&D recovery. The goal of proposed legislation regarding Tennessee's C&D waste stream should be straightforward: *C&D waste will not be land disposed unless it first passes through a state certified C&D waste processing/recovery facility*. Experts in the field suggest that imposition of this pathway to disposal would result in 70 percent reduction in land disposal of C&D[31]. Based on generation estimates this translates into the diversion of 1.8 million tons of C&D waste from Tennessee's Class I and Class III/IV landfills. Tennessee currently does not have the recovery infrastructure in place for sweeping legislation towards this goal. Markets for C&D recyclables alone will not spawn recovery infrastructure. Tennessee needs to join other states and enact specific C&D waste legislation.

One of the biggest impediments to recovery of C&D waste is lack of specific information about the waste stream. There are several issues that require study to guide proposed legislation. Questions regarding potential hazardous components of C&D waste need to be addressed both with regard to recovery products including for example, leachability characteristics of wood mulch and ADC and questions regarding leachate generation in Class III/IV landfills and the potential impact on groundwater. Tennessee has an opportunity to enact legislation to divert this waste to recovery facilities based on the fact that some of its jurisdictions are already diverting C&D waste from Class I landfills to Class III/IV landfills.

**Legislative initiative directed toward filling some of the data gaps regarding these waste streams.** This legislation would:

- Incorporate continued legislation that funds studies regarding these waste streams.
- Require counties and municipalities to estimate and report how much C&D waste is generated within their jurisdictions.
- Require all Class III/IV landfills and all C&D recovery operations to have functional scales.
- Possibly levy a small tax on land disposed C&D waste to fund the proceeding elements of this legislation.(see recent Ohio legislation)

**Legislation that effectively phases out the 1996 amendment to the Solid Waste Act of 1991 that allows jurisdictions to count C&D waste disposed in Class III/IV landfills toward MSW diversion goals.** The legislation would:

- Require that C&D waste be diverted to state approved recovery facilities in order for jurisdictions to get "full" credit for MSW diversion.
- Encourage jurisdictions to adopt the Williamson county model for minimizing C&D disposal.

- Encourage jurisdictions and C&D mixed waste processors to provide ADC for Class I landfills from processed C&D waste.

**Legislation aimed at minimizing the amount of C&D waste disposed in Class I landfills and Foster Private Sector Investment in Recovery Facilities.** Legislation that would:

- Require jurisdictions with Class I landfills to stipulate that a second haul route will be operated for transporting C&D waste to C&D waste facilities. In cases where C&D recovery facilities are not available locally, MSW companies would be required to establish or through a third party establish a mixed C&D waste processing facility and a Class III/IV landfill on or adjacent to the Class I site.

- Require that a minimum of 50% of the C&D wastes entering these facilities be diverted as recyclables or to ADC for the Class I landfill.

Legislatures are referred to the following state bills that contain elements of the aforementioned recommendations:

- California: SB 1374, 2002;
- Massachusetts Recent Ban on C&D Waste Going to a Landfill;
- Ohio Bill levying a per ton tax on landfilled C&D waste.

**Legislation aimed at developing a construction and demolition diversion ordinance to assist Tennessee counties with diverting C&D waste material.** A construction and demolition ordinance is a publicly adopted law that gives jurisdictions enforcement authority for the diversion activities mandated in the ordinance. In order to accomplish this task, the legislation should:

- Identify the types and quantities of projects in Tennessee that generate C&D material,
- Involve all interested parties (facilities, haulers, contractors, attorneys) in the process,
- Become familiar with other state's diversion ordinances (California is a good reference),
- Develop an ordinance implementation process that includes methods for encouraging C&D diversion

In addition to these specific recommendations regarding C&D waste the following list of C&D waste regulatory best practices developed by the Florida Department of Environment contain elements that may be germane to Tennessee legislation[32].

**Local government can do the following:**

- Fund public education and outreach programs designed to educate the public and to create small business opportunities for the municipality;

- Implement a mandatory recycling policy of selected materials prior to permit issuance when the dollar value exceeds a specific threshold i.e. $50,000;
- Implement curbside collection for selected C&D materials;
- Decriminalize the salvaging of building materials from demolition sites;
- Implement Green Building programs;
- Provide tax incentives to businesses that recycle;
- Maintain an open market for C&D debris collection;
- Issue permits to roll-off box haulers but not to franchises;
- Require non-exclusive commercial franchises, and
- Rebate a portion of the franchise fee if recycling occurs.

**State governments can do the following:**

- Fund a public education and outreach effort to educate the public on C&D issues and opportunities;
- Enact a Green Building bill for all state and local government building and renovation projects with a high recycling of C&D materials goals;
- Enact a "Recyclable Construction and Demolition Debris" (RCDM) bill;
- Prohibit solid waste franchises from covering C&D debris with clay based soil and instead require the covering be quality compost (Clay coverings contained in Ohio's RCDM legislation);
- Make a distinction between material recovery facilities and non-recycling processing facilities;
- Require C&D debris to be processed before disposal (a Massachusetts law);
- Require liners for C&D debris disposal facilities;
- Provide sales tax exemptions for recycling equipment, i.e., on-site grinding equipment;
- Provide sales tax exemptions for recycled construction materials;
- Provide grants to local governments to improve C&D debris recycling, and
- Provide low-interest loans to recycling businesses.

There are a number of examples of policies that states and cities have instituted to encourage C&D recycling. In San Jose, California, demolition contractors must pay a deposit based on the square footage of their project in order to receive a city building permit. The deposit is refunded if the contractor can demonstrate that the C&D waste was taken to a city-certified recover facility.

In Portland, Oregon the city requires job-site recycling of rubble (concrete/asphalt), land-clearing debris, corrugated cardboard, metals and wood on all construction and demolition projects with a

permit value exceeding $50,000. This is accomplished by requiring a complete site plan prior to permit issuance.

Another example is in Florida, where state solid waste legislation established recycling goals for counties, and a certain amount of C&D waste was allowed to count toward those goals. A cap was placed on the amount of C&D waste that could be counted toward that recycling goal so that counties would have to recycle other types of waste as well[32].

# ORGANIC WASTE ANALYSIS

**Dealing With Organic Waste**

Of the over 13 million tons of total ~~organic~~ MSW produced in TN, 31% is yard, food and wood waste.

- **The TOP 10 produce 9 million of the state's 13 million tons of organic waste each year.**
- **The TOP 10 dispose of three times the nation's MSW.**

By adding tonnages from an **additional 8 counties of 'interest'** (Madison, Montgomery, Sumner, Sevier, Dyer, Warren, Cumberland, and Carroll)**, the quantity of organic MSW generated is 11 million tons of the 13.3 million tons produced statewide.** See **Appendix D** for details regarding these counties.

**Defining Organic Waste**

This study uses EPA recognized definitions for the following solid categories[33]:

- **Food Scraps** – Uneaten food and food preparation wastes from residences and commercial establishments (restaurants, supermarkets, and produce stands), institutional sources (school cafeterias), and industrial sources (employee lunchrooms). Food scraps do not include waste from agricultural and industrial operations.
- **Yard Trimmings** – Grass, leaves, tree stumps, brush and branches from the residential and commercial sector. Does not include yard trimmings from construction or demolition debris. Grass clippings comprise 50% of all yard trimmings; 25% is brush; and 25% is leaves[34].
- **Wood Waste** – Pallets, crates, barrels, and wood found in furniture and consumer electronics. Does not include wood from construction and demolition debris or industrial process waste (shavings and sawdust).

**Recovery of Organics in the Municipal Solid Waste Stream**

**Comparing the National recovery rate for organics with Tennessee's rate is neither easy nor accurate.** This is due in part to Tennessee's use of a 'more inclusive' system of data collection. It includes system includes some data that fall outside of EPA's definition of MSW. For example, in the Annual Progress Reports, it is acceptable to include composting of wood chips and sawdust from commercial sawmills as diversion from the MSW stream. EPA's definition of wood waste, explicitly bar this as they are industrial process waste. Therefore, the figures would neither be counted toward the total MSW generated nor the amount recycled. However, these inflated statistics are the only ones available; therefore they must be used to compare Tennessee to the national average.

TN recovered only 28% of yard trimmings and wood waste generated in 2005, compared to 46% for the nation. This statistic is even more dismal when we realize the figures for **Tennessee includes compost, landscape and agriculture uses, and mulch in their figures, while those reported for the Nation do not. Comparing statistics for food waste recovered in Tennessee (8.2%) with those of the nation (2.4%) are misleading as well. Tennessee includes** food compost, animal feed, oil & grease, and food processing remnants in their data. These are banned from inclusion in national statistics.

| 2005 Organics Recovery from Municipal Solid Waste<br>Comparison of Tennessee and National Figures | | | | |
|---|---|---|---|---|
| **ORGANIC WASTES** | | **Tons Generated** | **Tons Recovered** | **Percent Recovered** |
| **YARD TRIMMINGS** | | 32,070,000 | 19,860,000 | 61.9% |
| Nation | | | | |
| Tennessee | 13.1% of total MSW | 1,750,718 | *>109,939*[a] | >6.3% |
| **WOOD WASTE** | | 13,930,000 | 1,310,000 | 9.4% |
| Nation | | | | |
| Tennessee | 5.7% of total MSW | 761,763 | *<600,112*[b] | <78.8% |
| **YARD TRIMMINGS + WOOD** | | 46,000,000 | 21,170,000 | 46.0% |
| Nation | | | | |
| Tennessee | | 2,512,481 | 710,051 | 28.3% |
| **FOOD, OTHER** | | 29,230,000 | | 2.4% |
| Nation | | | 690,000 | |
| Tennessee | 11.9% of total MSW | 1,590,347 | *130,408*[d] | 8.2% |
| [a] High because it includes figures for Compost + Landscape & Agriculture which are not counted in nation/EPA totals. | | | | |
| [b] High because it includes all figures for Mulch. | | | | |
| [c] TN's Annual Progress Reports do not distinguish between solid wood source mulch (wooden pallets, lumber, etc.) & woody yard trimmings mulch. For a more realistic picture of TN's yard & wood waste recovery efforts and comparison to national figures it is assumed the mulch reported is from both categories. | | | | |
| [d] High because it includes figures for Food Compost, Animal Feed, Oil & Grease, & Food Processing Remnants which are not counted in nation/EPA totals. | | | | |

**Table 3**: National figures from *Municipal Solid Waste in the United States: 2005 Facts and Figures* (EPA 2006). TN figures from 2005 Annual Progress Reports. Recovery totals based on diversion activities in Organics categories.

BURNT, a Nashville citizen's environmental group, calculates that Nashville produces 335 tons of commercial, business, and school waste from food and yards each day. If you multiply the daily tons by 6 of the 7 days of the week, and then multiply that number by the 52 weeks in a year, you get an estimate of more than 100,000 tons of organics landfilled annually. If you apply similar calculations to the TOP 10, the results are staggering!

**Markets for Organics Waste**

Research shows that **for any waste recovery program to be successful, it is imperative to IDENTIFY and ESTABLISH markets.** Unmarketable goods are the downfall of even the best managed program. **Discerning the 'end use' of the waste and quality expectations of the buyers are key to achieving** usable and salable end product.

A useful reference prior to program initiation is EPA's *Decision-Makers Guide to Solid Waste Management, Volume II, 1995.* A list of potential compost clients for **Compost & Mulch Markets**, an inventory of possible food waste clients can be found under **Food Waste Markets**, and a few **Additional Markets for Tennessee Organic Recyclables** are in **Appendix E.**

**EPA's Hierarchy at Work**

EPA ranks source reduction (including reuse) as the most environmentally sound MSW strategy. It is closely followed by recycling and composting. Disposal in combustion facilities is third and considered only slightly better than landfilling. This report deals with SOURCE REDUCTION and RECYCLING, the top two approaches.

**EPA's FIRST CHOICE: Source Reduction (Waste Prevention)**

**Source Reduction keeps materials from entering the waste stream**. Although these efforts do not count toward MSW recycling rates (because the materials technically never enter the waste stream), source reduction strategies can be highly effective at reducing municipal solid waste.

**Twenty-one states and the District of Columbia have legislation that restricts landfilling of yard wastes.**[35] With MSW disposal/per capita in Tennessee over twice the national average, source reduction / waste prevention is the most logical and cost effective means to reduce our solid waste. Additionally, if **Tennessee uses the 'Reduction from Base Year' method** to calculate the legislatively mandated 25% reduction rate, **source reduction programs could play a pivotal role in achieving statewide goals.** A classic model provided by EPA is the Del Mar, California county fair example as shown in **Appendix E.**

Source reduction opportunities for organics in municipal solid waste include: Food Recovery and Donation, Grasscycling, Backyard Compost, On-site composting by business and institutions, and Reuse of wooden pallets and crates.

**Food recovery and donation could address the estimated 1.59 million tons of food waste produced in Tennessee each year (nearly 1 million tons from the TOP 10 alone!) as well as help feed the thousands of Tennesseans who face hunger or food insecurity each day.** This strategy involves collection of pre-consumer food scraps and distributing edible food to the needy through food banks, shelters, soup kitchens, etc. Under the 1996 Good Samaritan Food Donation Act, donors are protected from liability if donated food is good at the time of donation. The best opportunities for collecting large quantities of edible food waste lie with grocery stores (especially produce, deli, and bakery departments), restaurants, hotels (over-produced catering items), institutions (schools and cafeterias), and produce wholesale warehouses. A successful program is the 'Fork It Over! Campaign' in Portland, Oregon. This program pairs regional food banks with the solid waste agency to divert food waste from groceries and restaurants to those in need of food. It has resulted in 9,000 tons of food recovered/diverted annually. Additional innovative programs found in the case studies are in **Appendix E.**

*Grasscycling* is a relatively low-cost strategy employed by local governments across the country to reduce the disposal of organics. Residents, businesses, and institutions are encouraged to leave grass clippings on the lawn instead of bagging and disposing of them. EPA estimates that grass clippings account for **50% of all yard trimmings, so grasscycling could address the**

**estimated 8.8 thousand tons of clippings generated in Tennessee (nearly 5.1 tons are generated in the TOP 10).** This strategy relies on educating the public to avoid infrastructure-related problems associated with other tactics. Some government programs offer financial incentives such as rebates on the purchase of mulching mowers or mulching retrofit blades to increase participation. Financial benefits of grasscycling include avoiding collection and disposal costs. Environmental benefits of this source reduction scheme include but are not limited to:

- reducing the amount of fertilizer needed (because nutrients from clippings are returned to the soil),
- improving moisture-retention, and
- decreasing soil temperatures in summer.[36]

A survey of home composting programs conducted by the Composting Council reported that each participating households diverted more than 1 ton of yard waste each year by grasscycling. EPA reports average **program cost** diverted amortized over 5 years, **is $1.03 per ton,** ranging from as little as **$0.26/ton** in Montgomery County, Ohio to as much as **$7.04/ton** in Dubuque, Iowa[37]. This is substantially less than tipping fees charged at landfills and collection costs are entirely avoided. Additional case studies are described in **Appendix E.**

*Backyard Composting* involves subsidized or free distribution of home composting bins and other educational and demonstration efforts. Residences can compost food scraps (except meat, dairy, bones, and grease) and yard waste as well as paper. Average participating households divert 650 lbs/yr through composting and produce 0.75 cubic yards of compost.[38] Residents gain increased awareness of their own organic waste generation[i] and gain a valuable soil amendment for yards and gardens from their efforts. Savings are realized by avoiding collection and disposal charges, estimated at $55/ton ($23/ton for collection, $32/ton for disposal).[39] **Midrange cost per ton diverted is $12.90, and this includes education, training, and bin subsidation.**[40] William Rathje, Director of the Garbage Project at the University of Arizona, reports 72% of food scraps are compostable excluding meats, dairy, fats, and oils.[40] Consequently, food waste potentially addressed by this approach is 36% (4.3% of the total MSW stream). **In Tennessee, the applicable portion of food waste for disposal is over 274,000 tons (nearly 161,000 tons in the TOP 10).**

Ninety percent of yard trimmings are generated by the residential sector.[41] If we subtract 10% for yard waste items that are large or not easily composted (i.e. tree trunks, large limbs) 81% could be composted at home. This is about 10.6% of the total MSW stream. In Tennessee, the applicable portion of yard waste for disposal is 1.4 million tons (over 832,000 tons in the TOP 10). If applied to food and yard waste, backyard composting could address 14.9% (2 million tons) of Tennessee's municipal solid waste (1.2 million tons in the TOP 10). **If even one-third of yard wastes were composted, the impact on Tennessee's disposal rate would be significant.**

*Onsite Composting by Businesses and Institutions* could greatly reduce waste collection and disposal costs as well as promote a conservation ethic among participants. Processing onsite would provide further cash savings and result in high-quality compost to be used for landscaping onsite. Composting methods include windrows, in-vessel composting, and vermicomposting.

Some businesses generate primarily recyclable paper but very little food, yard, or wood waste. Others, such as restaurants and grocery stores, generate waste that consists almost exclusively of organics. Most businesses and institutions, including schools, prisons, and companies with employee cafeterias, probably produce an intermediate amount of organic waste. So, we can assume that the composition of business/institutional waste is similar to that of that of MSW as a whole. **If businesses / institutions produce 40% of Tennessee's solid waste, and 30.7% of that waste is organics, onsite composing by these groups would address 1.64 million tons of waste.** The greatest opportunities for onsite composting lie with schools, prisons, and companies with employee cafeterias. Many businesses and institutions across the Country successfully compost waste food products. **Appendix E** presents case studies of recognized award winners in EPA's Waste Reduction Record-Setters Project.

*Reuse of Wooden Crates and Pallets* is a strategy that should be explored. Pallets make up an estimated 65% of wood waste generated.[42] It is unclear how many currently being discarded would be suitable for reuse or repair and reuse. The Tennessee Materials Exchange http://www.cis.utk.edu/environmental/recycle/TME.shtml currently lists a number of entities interested in receiving used pallets, and this resource could be promoted by the state and county governments to help business and industry exchange wooden pallets for reuse.

**EPA's SECOND CHOICE: Recycling**

Recycling turns materials that would otherwise be waste into valuable resources. Opportunities for recycling organics in municipal solid waste include:

*Yard Trimmings Collection and Municipal Composting* targeting commercial and residential components of yard trimmings can be cost effective while yielding a high-quality marketable product. A number of cities and counties throughout the U.S. do this quite successfully. Reducing the frequency of regular garbage collection is one way to offset the cost of adding yard trimmings collection. Possibly more effective is the offering of a tiered system of garbage collection, whereby residents pay for a particular size garbage container. Rates ore reduced for residents who lower their level of service by using smaller garbage containers and separating out yard trimmings. Programs can be designed to collect through curbside collection, participant drop-off of yard waste at designated locations or a combination of both collection methods. Some programs rely entirely on drop-off except during peak months, when curbside is offered. Local governments save when leaves, grass, and brush can be composted at a centralized location. Composting facilities often charge significantly lower tipping fees than landfills, providing an incentive for waste generators and haulers to separate these materials from garbage. Midrange costs for yard waste composting is $21.65 per ton diverted,[43] excluding collection costs, which are presumed to be similar to those for garbage collection.

Composting of yard trimmings may use relatively low-tech methods, such as piles of leaves turned occasionally by front-end loaders, to high-tech facilities that employ size reduction equipment, dedicated windrow turners, and screening equipment.[44] Low-tech operations have lower capital and operating expenses but require more time for composting to occur, so more land area must be available to process more than one season of material. Brush should generally be processed by size-reduction equipment prior to composting. Chips can be processed separately and marketed as mulch, or used as a bulking agent for composting high-nitrogen

materials like grass. **Together these processes address the 1.75 million tons of yard waste generated in Tennessee each year (1 million tons in the TOP 10).**

In an EPA study of 500 U.S. municipalities curbside and drop-off yard trimmings collection programs diverted an average of 90% of all yard wastes generated in a given area. The potential impact of this strategy in Tennessee is enormous. **If yard trimmings collection programs were implemented in the TOP 10, almost a million tons (or 6.9% of Tennessee's total MSW) could be diverted from landfills. As an added benefit, this strategy also produces high-quality products for market to generate revenue.**

The state of Iowa actually bans yard trimmings from landfills. The Linn County Solid Waste Agency in that state processes 41,000 tons of organics/yr. The tipping fee for yard trimmings is $15/ton, less than half the $35/ton landfill tipping fee. Annual operating costs average $14.49/ton. In FY 2004, this program sold 15,382 tons of bulk/bagged products, including shredded wood mulch, screened compost, topsoil, packaged potting soils, and unscreened compost (used for erosion control).[45] Additional successful marketing examples can be found in **Appendix E.**

*Animal Feed-* Food donation is the highest use for surplus and/or leftover food; the next highest use is animal feed.[46] Food scraps can be diverted from landfills by giving or selling them directly to area farmers, or allowing collection of food residuals by companies that process them into high-quality pelletized animal feed. **This strategy could target the 50% of food scraps, including food residuals generated by restaurants, schools, hospital, grocery stores, bakeries, and cafeterias.** Participating businesses would reduce waste collection and disposal costs and provide a low-cost source of feed for area farmers.

Barthold Recycling and Roll-off Services in St. Francis, Minnesota is a flourishing example of recycling food scraps for animal feed. The company diverts approximately 1,000 tons of food scraps per month from 400 area businesses to feed its 3,800 pigs and 250 head of cattle. To comply with state and federal regulations, the company developed an innovative method of using steam pipes to cook the food scraps in the trucks after collection. Strong relationships with customers have resulted from Barthold's providing education, training, and special containers with rubber gasket seal lids to reduce odors and leakage. Education and training has paid off and Barthold boasts of a final product that is 99.75% free of contamination. Clientele are appreciative and report benefits such as increased cleanliness and reduced labor costs. Customers pay 30% less to recycle food residuals than for landfill disposal!

*Source-Separated Organics (SSO) Composting* participants separate specified organic materials for collection and processing. **This could address the 3.34 million tons of food and yard waste produced in Tennessee (1.96 million tons produced in the TOP 10).** Some programs accept various paper grades in addition to food and yard waste, increasing the diversion potential. Some communities don't accept meat or greasy food items. Others have easily added food residuals to existing composting programs and found that food scraps are such a small component of the overall mix that there have been no significant program changes for them.[47] Resulting SSO compost has substantially lower levels of toxic heavy metals and physical contaminants than that from mixed waste.[48]

A fine example of SSO composting benefiting the local community is in Wayzata, Minnesota. Here the city includes food residuals and non-recyclable paper in its composting program while keeping costs per household low. Residents have the option of subscribing to a "lower level of service" for garbage collection (e.g., choosing a smaller collection container and/or receiving collection every other week instead of weekly). Citizen costs have decreased with the added organics collection and in the first two years of the program there has been a 12% decrease in trash and a 23% increase in recycling! This is attributed to citizens' increased attention to separating their waste.[49] Further additional case studies are shown in **Appendix E.**

*Mixed Municipal Solid Waste Composting* facilities accept mixed waste and separate the materials for composting, disposal, and sometimes recycling. Mixed waste composting can divert all food, yard, and wood waste **(4.1 million tons statewide, half from the TOP 10)** and possibly divert a portion of the **state's nearly 4.6 million tons of waste paper (2.7 million tons in the TOP 10)** and bio-solids from sewage treatment facilities. These bio-solids are not technically considered municipal solid waste but are often disposed of in Class I landfills. Unlike other organics recycling options all the waste goes to a centralized facility for separation. Some programs yield good-quality compost while lesser quality composts are often used as alternate daily cover for landfills.[50] Currently 14 mixed MSW composting facilities are in the U.S., with capacity ranging from 5 to 245 tons per day.[51] Midrange costs are estimated at $63/ton diverted.[52]

A 'local' mixed MSW composting facility in Sevierville, TN where Sevierville Solid Waste, Inc. operates the largest capacity mixed waste facility in the U.S. Increasing costs associated with landfill expansion drove a decision to increase mixed waste composting. In 2006 total capacity was increased to 245 tons/day of MSW, plus 40 tons/day of bio-solids. Finished compost is an alternate daily cover for the landfill or given to area farmers. (Sources: Emerson 2005, Spencer and Goldstein 2006; Tom Leonard, personal communication, Nov. 2006)

*Rendering* is an industry that collects, processes, and reclaims 36 billion pounds of inedible animal waste by-products annually, thereby preventing it from being landfilled.[53] Sources include slaughterhouses, poultry, processors, packing plants, butcher shops, supermarkets, hotels, and restaurants. Nationally, nine billion pounds of animal fat are reclaimed annually.[54] The heating process in rendering produces by-products free from pathogens, viruses, and other conventional organisms and allowing for extended shelf life of products.[55] Goods produced from rendered fats and proteins result in[56] a concentrated high energy source for use in animal and poultry feed and fertilizers. Fatty acids and tallows are used in a number of everyday items[57] including soaps, gelatins, cosmetics, paints, varnishes, polishes, water repellents, rubber, and biodiesel. Renderers recycle 95-100% of discarded material into useful products and contribute more than $1.5 billion to the Gross National Product.[58]

In Tennessee, Griffin Industries and Bakery Feeds provide removal services for inedible animal waste, cooking oils, trap grease and bakery waste in six locations statewide.[59] The Garbage Project at the University of Arizona estimates that 28% of food waste is meat, dairy, and grease. Rendering could easily be used to manage this portion of commercial waste. **Statewide, it could address nearly 223,000 tons of food waste per year (131,000 tons produced in the TOP 10).**

*Mulching wood waste* chips, grinds, or shreds clean wood. Mulch has a variety of uses, and can be used in-house by local governments or given or sold to the public. Mulching addresses the 65% of wood waste made up of pallets[60] and the 25% of yard trimmings that are brush.[61] Small amounts of brush can be processed with wood chippers, but larger quantities require processing with a tub grinder or other heavy size-reduction equipment.[62] **Many Tennessee counties already have such mulching operations**. Over 600,000 tons was mulched in Tennessee in 2005. A number of counties did not report mulching activity, so this strategy should be encouraged in counties that do not have mulching operations. **In Tennessee, mulching has approximately 933,000 tons of diversion potential (including 548,000 tons in the TOP 10).**

**A Last Reason to Deal with Organics**

There are additional financial and environmental reasons to deal with the landfilling of organics. Two of the most hazardous are dangerous gasses that result from organics decomposition within landfills. The second is landfill leachate entering groundwater.

Methane and other gases, collectively known as 'landfill gas', are not pure methane as the 'landfill gas to energy' proponents would lead the public to believe. It contains a number of other hydrocarbons (ethane, butane, propane) as well as nitrogen, water, carbon dioxide, sulfur compounds, halogenated compounds, and even substances like mercury. These gases result from the decomposition of organics that have been landfilled. If not siphoned off, the gas can build up pressure to dangerous levels. Landfills with gas collection systems capture relatively little that is produced. Those with systems that directly burn landfill gas negatively affect air quality. Dealing with this problem continues to be costly in regard to air quality and the environment.

Equally problematic is the high moisture content of organics, which forms leachate when landfilled. Anaerobic decomposition produces acids that dissolve substances out of wastes as moisture and liquids filter through landfill contents. The result is a toxic soup of liquids that collects and can ultimately leak into the surrounding soil.

In the FEDERAL REGISTER, **EPA stated that in its opinion all landfills eventually leak**: "A liner is a barrier technology that prevents or greatly restricts migration of liquids into the ground. No liner, however, can keep all liquids out of the ground for all time. Eventually liners will degrade, tear, or crack and allow liquids to migrate out of the unit." [pg. 32284] Recent research and other EPA documentation on leaking landfills are plentiful. Dickson County, Tennessee is home to one such site in our state.

**Conclusions for Organic Wastes**

The state of solid waste in Tennessee does not look good. We generate 2.24 tons/yr per capita of municipal solid waste **(over two times the national average).** The TOP 10 counties alone generate **over three times the national average**. Tennesseans dispose of 1.12 tons/yr/per capita in Class I landfills versus the national average disposal rate of .45 tons/yr/person for MSW. In addition, **Tennessee has no 'common vocabulary' when it comes to how solid waste data is collected and reported**. The State loosely defines what to actually include in that data and legislatively has supported the use of 'mixed' methods to calculate solid waste numbers statewide.

- Tennessee's most urgent solid waste management need must be determined. Is it 25% waste reduction (an imperative that has been legislated but remains unmet), hazardous materials, e-waste, landfill leakage, methane gas, or organic waste?
- The composition and origins of MSW generated in Tennessee must be identified.
- An infrastructure, funding, and an environment for compliance must be established in order for composting of organics to be successful.

**A good beginning may be to 'cookie cut' and implement programs** that work from other locations, but waste reduction here must be taken further. Tennessee has its own unique demographics, economy, climate, and natural resources, all of which must be considered in developing environmental programs for waste reduction that promote citizen compliance.

No program to reduce organic waste will be successful without creating an environment to conserve resources. A public need for change must be created and education provided concerning actual methods of composting. Before initiating large scale composting programs **the State must assist in encouraging and finding suitable markets for compost produced.** Composting is a sure way to reduce food and yard waste, but there must be markets for these products.

Lastly, state, local and federal government employees in Tennessee have a tremendous opportunity to be the leaders in reducing solid waste. **Incorporating sound source reduction and waste prevention practices** (composting, grasscycling, and food donation) **throughout the government** models active waste reduction and serves to educate the general public in the "urgent" need to reduce organics landfilled. The Government of Ontario, Canada provides a model for Tennessee to follow.

**Recommendations For Organic Waste**

Tennessee does not need more policies. The State must reduce organics and amounts landfilled and standardize the way MSW data is collected. We STRONGLY urge the 'copy cat' approach of identifying and implementing successful proven programs from other places to set in motion the overall reduction of food, yard waste, and other organics entering our landfills. As part of this we MUST determine needed infrastructure for successful organic waste reduction programs.

We MUST determine which aspect of the organics portion of the solid waste stream address first. Yard waste appears to be the "low-hanging fruit," and shows the greatest promise for effecting real reductions in Tennessee's solid waste disposal rate. Grasscycling, backyard composting, and yard trimmings composting are cost-effective strategies that have worked in cities and states across the US, and such strategies should be considered for implementation in Tennessee, **particularly in the TOP 10 counties.**

For effective implementation of organics composting, we propose these specific recommendations:

- municipal composting/mulching of yard waste
- grass-cycling education for homeowners with discount coupons for purchasing mulching mowers and mulching blades

- backyard composting education for homeowners with discount coupons for the purchase of compost bins
- funding for a pilot test program on food composting for Government institutions
- funding for a pilot test program on food composting for TP3 members, whether businesses, schools, institutions, or homeowners

Methods to insure success include:

- save on transportation costs by composting close to waste generation sources
- create a salable product or at least enable city/county governments to break even
- continue to use the Division of Community Assistance to assist Solid Waste Regions and Local Governments by providing the technical assistance needed to develop more accurate, consistent, and complete solid waste management information and reported data. through the Division of Community Assistance
- conduct on-site inspections and/or audits of landfill and composting facilities, and analyze the recorded data for these sites

Working for incremental change is the best option. We cannot and should not attempt to rewrite the Solid Waste Act. We should implement, highlight, and celebrate incremental positive changes which can result in big impacts within our current system.

# CONCLUSION

In this joint study, Tennessee State University has analyzed the present state of construction and demolition waste in Tennessee Class IV landfills, and outlined strategies to help facilitate a statewide diversion ordinance for these materials. Likewise, Middle Tennessee State University has examined the role of organic material waste in Class I landfills, and provided ample documentation on successful diversion programs for this waste stream. In addition to the recommendations that have already been made for these specific wastes, the TSU/MTSU study group would also like to make the following legislative recommendations that are germane to both studies.

**1) Conduct a Tennessee Specific MSW Composition and Characterization Study**
As was indicated in both studies, the collection of waste reduction is a challenge due to non-uniform standards in reporting waste reduction and diversion numbers. Strategies for reducing our solid waste could be better evaluated if there were better data on the actual composition of the solid waste stream in Tennessee. Generalizations can be made, based on EPA figures, but, as the composition of waste is known to vary, both regionally and within regions, these generalizations may not present an accurate picture. A solid waste composition and characterization study would help solid waste decision makers prioritize waste reduction efforts based on real data on Tennessee's trash.

**2) Develop Uniform Standards of Reporting**
It is essential that Tennessee establishes and enforces policies for the statewide uniform collection and reporting of solid waste management data. There should be clear definitions on what is considered to be reportable when it comes to compost materials. These policies should also apply to the reporting of disposal data from private sector. A prime example is the elimination of the concept of "negative" counting whereby landfilling in Class IV landfills counts as positive toward recycling, thereby giving a "false count" to the amount and percentage of diverted solid waste.

**3) Strengthen Monitoring of Landfill Leaching**
Although leachate analysis was not the primary objective of these studies, both focus groups have identified the need for implementation measures to fix and/or prevent leaching of landfills into groundwater. Additional studies need to be conducted on the contamination of groundwater from landfill leachate. In addition, the joint TSU/MTSU study group recommends that a ban and/or restriction be placed on the ability of landfills to accept waste which can cause leachate (food, yard, hazardous, or otherwise).

**4) Hold Solid Waste Regions to a 25% Reduction**
As discussed in this report, this target reduction has not yet been met by the State of Tennessee, and would help to facilitate the reduction, diversion, and recycling of waste.

**5) Establish Consistent and Critical Criteria for Landfill Siting**

In closing, it is hoped that the data presented herein will be analyzed and prioritized according to the most urgent SWM needs in regards to health, safety, economics, and State regulations.

# REFERENCES

[1] Tennessee Department of Environment and Conservation. Division of Solid Waste Management, Planning, Reporting and Waste Reduction, Compliance Formulas_APR_2005. "Other Organic Recyclables listed with the 2005 Municipal Solid Waste Planning Region Annual Progress Report." Nick Lytle, Nashville, TN.

[2] California Integrated Waste Management Board. "Organic Options: Opportunities for Local Government Reuse, Recycling, and Composting."(Publication #310-02-015), Public Affairs Office, Publications Clearinghouse (MS-6),Sacramento, California www.ciwmb.ca..gov/Publications, Pg. 1.

[3] Tennessee Department of Environment and Conservation, Division of Solid Waste Management, Planning, Reporting and Waste Reduction, Compliance Formulas_APR_2005, Other Organic Recyclables listed with the 2005 Municipal Solid Waste Planning Region Annual Progress Report, Nick Lytle, Nashville, Tennessee.

[4] Ibid., p.3.

[5] Ibid., p.3.

[6] Ibid., p.3.

[7] Ibid., p.4.

[8] Tennessee Department of Environment and Conservation. Division of Solid Waste Management, Solid Waste Assistant Programs. "Annual Report to the Governor and General Assembly on the Solid Waste Management Act of 1991, Fiscal Year 2004-2005." P.17.

[9] Tennessee Department of Environment and Conservation. Division of Solid Waste Management, Solid Waste Assistance Programs. "Annual Report to the Governor and General Assembly on the Solid Waste Management Act of 1991, Fiscal Year 2004-2005." p.16.

[10] Tennessee Department of Environment and Conservation. Division of Solid Waste Management, Planning, Reporting and Waste Reduction, Compliance Formulas_APR_2005. Nick Lytle, Nashville, TN, p.1-15.

[11] U.S. Environmental Protection Agency. Municipal and Industrial Solid Waste Division. "Municipal Solid Waste in the United States: 2005 Facts and Figures, Executive Summary." Office of Solid Waste, October 18, 2006, p.12.

[12] Construction and Demolition Recycling, Interview with William Turley, Director of CMRA

[13] Construction and Demolition Commodity Profile, Markets Assessment 1998, North Carolina Department of Environment and Natural Recourses, p.1.

[14] Tennessee Department of Environment and Conservation, Division of Solid Waste Management, Database search, Nick Lytle, Nashville, Tenn.

[15] Franklin and Associates, June 1998a. "Characterization of Building-Related Construction and Demolition Debris in the United States." Prepared for the U.S. Environmental Protection Agency. Report No. EPA530-R-98-010. Franklin and Associates. 1998..

[16] Generation and Composition of Construction and Demolition Debris in Florida, State University System of Florida, 2003, pp. 59-73

[17] U.S. Census Bureau. March. "Construction – Geographic Area Series: Tennessee," 2002, Economic Census.

[18] U. S. Department of Commerce, Economic and Statistics Administration, Bureau of the Census, Expenditures for Residential Improvements and Repairs. First Quarter 1998, Current Construction Reports (C50/98, August, 1998.

[19] www.census.gov.Three percent is historically considered the average annual inflation in the U.S. and was therefore used

[20] www.dca.state.ga.us/development/research/programs/download/SWAR_2005_Chap01.pdf

[22] Comptroller of the Treasury, Tennessee's Trash in a New Century, Office of Research, June 2004, p.6.

[23] http://www.recyclecddebris.com/rCDd/Resources/WasteStudy/Chapter05.aspx

[24] http://www.cdrecycler.com/

[25] Comptroller of the Treasury. "Tennessee's Trash in a New Century." Office of Research, June 2004, p.4.

[26] Tennessee Department of Environment and Conservation. Division of Solid Waste Management, Planning, Reporting and Waste Reduction, Compliance Formulas_APR_2005. "Other Organic Recyclables listed with the 2005 Municipal Solid Waste Planning Region Annual Progress Report." Nick Lytle, Nashville, TN.

[27] Ibid., p.1

[28] EPA, 2006. "Municipal Solid Waste in the United States: 2005 Facts and Figures." EPA530R-06-011. Washington, DC.

[29] Comptroller of the Treasury. "Tennessee's Trash in a New Century." Office of Research, June 2004, p.3.

[30] Tennessee Department of Environment and Conservation. Division of Solid Waste Management, Solid Waste Assistance Programs. "Annual Report to the Governor and General

[31] Assembly on the Solid Waste Management Act of 1991, Fiscal Year 2004-2005". P.16.

[32] Comptroller of the Treasury. "Tennessee's Trash in a New Century." Office of Research, June 2004, p.5.

[33] Tennessee Department of Environment and Conservation. Division of Solid Waste Management, Solid Waste Assistant Programs. "Annual Report to the Governor and General Assembly on the Solid Waste Management Act of 1991, Fiscal Year 2004-2005." P.17.

[34] U.S. Environmental Protection Agency. Municipal and Industrial Solid Waste Division. "Municipal Solid Waste in the United States: 2005 Facts and Figures, Executive Summary." Office of Solid Waste, October 18, 2006, p.1.

[35] Ibid., p.12.

[36] Ibid., p.12.

[37] Ibid., p.12.

[38] Ibid., p.13.

[39] Ibid., p.13.

[40] Ibid., p.13.

[41] Ibid., p.14

[42] Ibid., p. 1-15

[43] Ibid., p.1-15

[44] Ibid., p.7

[45] Comptroller of the Treasury. "Tennessee's Trash in a New Century." Office of Research, June 2004, p.12.

[46] Comptroller of the Treasury. "Tennessee's Trash in the 1990's." Office of Research, an update, July 1998.

[47] Comptroller of the Treasury. "Tennessee's Trash in a New Century." Office of Research, June 2004.

[48] Comptroller of the Treasury. "Tennessee's Trash in a New Century." Office of Research, June 2004.

[49 EPA.1997. "Measuring Recycling: A Guide for State and Local Governments." EPA530-R-97-011. Washington, DC.

[50] EPA. 2006. "Municipal Solid Waste in the United States: 2005 Facts and Figures." EPA530-R06-011. Washington, DC.

[51] Simmons P, N Goldstein, S.M. Kaufman, N.J. Themelis, J. Thompson Jr. (April 2006). The State of Garbage in America. BioCycle.

[52] EPA. 1992. "Environmental Fact Sheet: Recycling Grass Clippings." EPA530-F-92-012. Washington, DC.

[53] EPA. 1999. "Organic Materials Management Strategies." EPA530-R-99-016. Washington, DC.

[54] Composting Council. 1996. "Cost-Benefit Analysis of Home Composting Programs in the United States." Prepared by Applied Compost Consulting.

[55] New York City Department of Sanitation. 1999. "Backyard Composting in New York City: A Comprehensive Program Evaluation." New York, NY.

[56] Composting Council. 1996. "Cost-Benefit Analysis of Home Composting Programs in the United States." Prepared by Applied Compost Consulting.

[57] EPA. 1999. "Organic Materials Management Strategies." EPA530-R-99-016. Washington, DC.

[58] EPA. (1997). Source Reduction Program Potential Manual: A Planning Tool. EPA530-R-97-002. Washington, DC.

[59] EPA. (1997). Source Reduction Program Potential Manual: A Planning Tool. EPA530-R-97-002. Washington, DC.

[60] EPA. 1997. "Source Reduction Program Potential Manual: A Planning Tool." EPA530-R-97-002. Washington, DC.

[61] EPA. 1999. "Organic Materials Management Strategies." EPA530-R-99-016. Washington, DC.

[62] EPA. 1999. "Organic Materials Management Strategies." EPA530-R-99-016. Washington, DC.

[63] Emerson, D. (September 2005). Latest Trends in Yard Trimmings Composting. BioCycle. Cedar Rapids/Linn County Solid Waste Agency. (2005). Services – Composting. Retrieved on Monday, January 15, 2007 from www.solidwasteagency.org/services_composting.asp.

[64] Simmons P, N Goldstein, SM Kaufman, NJ Themelis, J Thompson JR. (April 2006). The State of Garbage in America. BioCycle.

[65] EPA 2006. "Putting Surplus Food to Good Use: A How-to Guide for Food Service Providers." EPA530-F-06-004. Washington, DC.

[66] Goldstein, N. (December 2005). Source Separated MSW Composting in the U.S. BioCycle.

[67] EPA. (1999). Organic Materials Management Strategies. EPA530-R-99-016. Washington, DC.

[68] Wirth, R. (September 2005). Diverting Food Residuals in Minnesota. BioCycle. Goldstein, N. (November 2005). Mixed MSW Composting Facilities in the U.S. BioCycle.

[69] Spencer, R, Goldstein, N. (November 2006). Mixed MSW Composting is "Steady As She Goes. BioCycle.

[70] EPA. (1999). Organic Materials Management Strategies. EPA530-R-99-016. Washington, DC.

[71] Environmental Perspective, National Renderers Association, Inc. www.renders.org/links/enviro.htm1/30/2007 5:34 AM

[72] "Proper Dead Animal Disposal", The Bulletin Oct. – Dec. 2006, National Renderers Association, Inc. p.4., www.renderers.org/links/top.htm 1/30/2007 5:34 AM

[73] Company: What We Do, Welcome to Griffin Industries, p.1. www.griffinind.com/Griffin%2004%20Site/pages/CO%wh

[74] Ibid., p.1.

[75] EPA. (1997). Source Reduction Program Potential Manual: A Planning Tool. EPA530-R-97-002. Washington, DC.

[76] EPA. (2006). Municipal Solid Waste in the United States: 2005 Facts and Figures. EPA530-R-06-011. Washington, DC.

[77] EPA. (1999). Organic Materials Management Strategies. EPA530-R-99-016. Washington, DC.

**Appendix A**: Legislative History of Solid Waste Management in Tennessee

**Appendix B**: TDEC Class I & Class IV Landfills

**Appendix C**: Total Reported Waste Generated

**Appendix D**: Total Generation, Disposal Per Capita, Diversion Per Capita

**Appendix E**: Case Studies: Successful Composting and Recycling Programs

**Appendix F:** Problems Associated with the Disposal of Organics

# Appendix A

## Legislative History of Solid Waste Management in Tennessee

A.1 Outline of TN Solid Waste Legislation
A.2 Legislative History of Solid Waste Management in TN

# OUTLINE OF
# TENNESSEE SOLID WASTE LEGISLATION

The TN **Solid Waste Disposal Act (SWDA) passed 1969**- giving state authority

- to regulate local dumps
- to manage solid waste disposal

The **Solid Waste Management Act (SWMA) passed 1991**

- Plan for Municipal Disposal Capacity & Waste Reduction
- initial by deadline 1995/ or before 1996; target dates since have varied because goal has yet to be met
- Act challenges each Region to reduce the amount of solid waste disposed of in Class I landfills and incinerators by 25%- Act requires **Annual Report** to be made on **TN's Solid Waste Management System (SWMS)**
    - **Annual Report**
        - Report is collaborative effort by TDEC: Division of Solid Waste Management and Office of Environmental Assistance
        - Report is submitted to the General Assembly and Governor
    - **TN's Solid Waste Management System (SWMS)**
        - System was developed by TDEC to mirror the waste management system established by EPA (Integrated Solid Waste Management System in 1995)
        - System is intended to facilitate regulatory activities and enforcement of TDEC
        - System is a 3 prong approach to better manage TN's solid waste
        - System includes providing and promoting :
            - **technical assistance**
                - Development Districts
                - Recycling Marketing Cooperative for TN (RMCT)
                - University of TN- Center for Industrial Services (UT CIS)
                    - TN Materials Exchange (TME)
                    - Recycling Markets Directory (RMD)
                - University of TN- County Technical Assistance Service (UT CTAS)
            - **education**
                - America Recycles
                - Schools Chemical Cleanout Campaign (SC3) with support from :
                    - TN Organization of School Superintendents,
                    - TN Science Teachers Association (TSTA)
                    - TN Academy of Science (TAS)
                - State Employee Recycling Program (SERP)
                - TN Great American Cleanup
                    - sponsored by Keep TN Beautiful
                - TN Solid Waste Education Project
            - **diversion / resource recovery**
                - Household Hazardous Waste (HHW)
                    - HHW Mobile Collection Service
                - State Parks Recycling
                - Waste Tire Management
- Act made each county a **SW planning District** to assist implementation of the SWMS

- Act allowed Districts (counties) to in turn collaborate with local municipalities and neighboring counties to form **MSW Regions**
    - Act requires each MSW Region to
        - develop a 10 year plan for their solid waste,
        - provide for solid waste education to its population, and
        - plan to reduce the amount of waste it generates by 25%
        - **Annual Progress Reports (APRs)** that project foreseeable solid waste disposal requirements and proposed solutions; Each Region uses APR to project changes in solid waste generation and to modify its 10yr plan
- 66 Regional Planning Boards have the responsibility for developing the plans and for reporting this info to TDEC
- Act outlines the use of the funds in only a few brief sentences; basically 'may award grants'
- Act set forth specific provisions to further this waste reduction goal;
    - Act made one provision the establishment of the **Solid Waste Management Fund (The Fund)**
    - the Fund exists to support
        - solid waste planning and
        - reduction activities and
        - solid waste education
    - the Fund was established to provide financial support in addressing:
        - waste avoidance,
        - waste reduction,
        - recycling,
        - composting, and
        - household hazardous waste disposal
    - The **Solid Waste Management Fund (SWMF) : total ~yrly revenues $9.5 mil/ yr**
        - revenues from surcharge per ton of soil waste disposed of in Class I landfills $5.3 mil/yr;
        - revenues from disposal fees on new tires sold in TN $4.2mil/yr
        - distributed primarily through grants and services; mostly to:
            - local government/ municipalities and
            - other eligible entities such as non-profit recyclers (example....RMCT)
        - establishes grant criteria and eligibility
        - solicits and/or provides grants through review of applications/ submittals
        - **to implement the SWMS, TDEC disperses monies from the Fund through**:
            - ❖ **grants**
                - to aid in solid waste planning/ given to:
                    - local governments
                    - educational institutions
                    - MSW Regions
                    - Development Districts
                - to assist in solid waste facility upgrades, purchase of recycling equipment, recycling of waste tires, and collection of household hazardous waste at permanent facilities; given to:
                    - county governments
                    - local governments
                - these are competitive and are rated by criteria
                    - Such as recycling equipment, recycling rebates, waste tire recycling, Used Oil Grant
            - ❖ **contracted services**
                - **Clean Harbors** is currently contracted to consolidate/ handle materials gathered from county driven HHW collection events

- **Greater Nashville Regional Council (GNRC)**

  The primary areas of GNRC involvement in FY 2002 included:

  - Planning, programming, technical assistance, annual report preparation, recycling, education, coordinating Middle Tennessee Solid Waste Directors' meetings and serving on the Board of Directors of the Recycling Marketing Cooperative of Tennessee (RMCT).

- **Solid Waste Task Force**

  To undertake a comprehensive review of the Solid Waste Management Act to make detailed recommendations to the **Solid Waste Advisory Committee (SWAC)** by June 2003. The SWAC was to use the information if the Solid Waste Management Act underwent reauthorization review by the Tennessee General Assembly in 2004

**Sources:**

http://www.tennessee.gov/tsla/history/state/recordgroups/findingaids/rg308.pdf

http://www.cityofmemphis.org/framework.aspx?page=669

http://www.gnrc.org/solidwaste.htm

**Exhibit 1: Legislative History of Solid Waste Management in Tennessee**

| Year & Public Chapter | Major Provisions* |
|---|---|
| 1991 - Public Chapter 451: "The Solid Waste Management Act of 1991" | • Established 25 percent per capita state waste reduction goal, with 1989 as base year and 1995 as goal year;<br>• Established Development Districts as solid waste planning districts; required plans for 10-year disposal capacity, and annual progress reports;<br>• Established state municipal solid waste advisory committee;<br>• Required by Jan. 1, 1995 that each county have at least one solid waste collection and disposal system;<br>• Required waste haulers to register with TDEC, keep records and report on waste hauled;<br>• Required Class I facilities to have scales and maintain records of waste disposed;<br>• Established tipping fee surcharge (85 cents), tire pre-disposal fee ($1.00), and Solid Waste Management Fund, and authorized grants to be paid out of these funds; and<br>• Required the establishment of a state solid waste planning and management database. |
| 1996 – Public Chapter 846: Reauthorization of the original act | • Repealed waste hauler registration;<br>• Re-authorized tipping fee surcharge and tire pre-disposal fee, but lowered the surcharge incrementally from 85-cents to 75-cents;<br>• Clarified that diversion of wastes to Class III/IV landfills counted toward solid waste reductions; and<br>• Mandated reporting of "green boxes," and allowed only those in existence before January 1, 1996 to remain. |
| 1999 – Public Chapter 384: "The 1999 Amendments" | • Extended the 75-cent tipping fee surcharge to June 30, 2004;<br>• Established 1995 as the new base year and December 31, 2003 as the new date for achieving the 25 percent reduction goal;<br>• Allowed waste reduction calculations to be done on an economic growth basis;<br>• Provided for qualitative assessments of regions' efforts to reduce solid waste if regions do not achieve the reduction goal, to determine whether the regions' efforts are equivalent to other regions that have met the goal. |
| 2004 – Reauthorization | • Reauthorized the 75-cent tipping fee surcharge and allowed regional 10-year plans to be revised at any time to reflect developments in the region. |

*This list is not all-inclusive; these acts contain other provisions not listed here.

*** This list provided by Comptroller of the Treasury. "Tennessee's Trash in a New Century." Office of Research, June 2004, p.3.**

# Appendix B

## TDEC Class I & Class IV Landfills

Class I Landfills in TN as of January 2005

## Class I Landfills in Tennessee as of January. 2005 with Phone Numbers Listed by County Location

| SITE ID | SITE_NAME | LOCATION | PHONE |
|---|---|---|---|
| SNL010000160 | CHESTNUT RIDGE LANDFILL AND RECYCLING CENTER | Anderson County | 865-457-7810 |
| SNL030000247 | WEST CAMDEN SANITARY LANDFILL | Benton County | 731-584-7734 |
| SNL050000105 | ALCOA /MARYVILLE/ BLOUNT CO. CLASS I LANDFILL | Blount County | 865-995-2892 |
| SNL060000006 | BRADLEY COUNTY CLASS I LANDFILL | Bradley | 423-476-8118 |
| SNL140000250 | UPPER CUMBERLAND LANDFILL | Clay County | 931-258-3954 |
| SNL180000212 | CUMBERLAND COUNTY LANDFILL | Cumberland Co. | 931-788-6127 |
| SNL200000254 | DECATUR LANDFILL, operated by WASTE SERVICES, INC. | Decatur County | 731-549-3567 |
| SNL210000243 | DEKALB COUNTY LANDFILL | DeKalb County | 931-761-5588 |
| SNL230000218 | DYERSBURG CITY LANDFILL | Dyer County | 731-286-0450 |
| SNL320000152 | MORRISTOWN BALEFILL LANDFILL | Hamblen County | 423-581-8784 |
| SNL320000274 | LIBERTY FIBERS CORPORATION LANDFILL | Hamblen County | 423-585-4805 |
| SNL320000280 | LAKEWAY SANITATION AND RECYCLING, INC. LANDFILL | Hamblen County | 423-581-5655 |
| SNL330000273 | CITY OF CHATTANOOGA LANDFILL | Hamilton County | 423-344-9737 |
| SNL350000223 | HARDEMAN COUNTY LANDFILL | Hardeman County | 731-658-6138 |
| SNL370000185 | CARTER VALLEY LANDFILL | Hawkins County | 423-357-6777 |
| SNL450000241 | JEFFERSON COUNTY LANDFILL | Jefferson County | 423-397-3544 |
| SNL530000203 | LOUDON COUNTY LANDFILL | Loudon County | 865-458-2651 |
| SNL540000003 | MCMINN COUNTY LANDFILL | McMinn county | 423-745-3244 |
| SNL540000174 | MEADOW BRANCH LANDFILL INC | McMinn County | 423-745-6396 |
| SNL570000239 | JACKSON CITY/MADISON CO. CLASS I LANDFILL | Madison County | 731-425-8548 |
| SNL580000197 | MARION COUNTY LANDFILL | Marion County | 423-942-8011 |
| SNL590000238 | CEDAR RIDGE LANDFILL, INC. | Marshall County | 931-359-9032 |
| SNL630000108 | BI-COUNTY SNL BALEFILL | Montgomery Co. | 931-648-5751 |
| SNL660000143 | NORTHWEST TENNESSEE DISPOSAL COMPANY | Obion County | 731-885-1941 |
| SNL660000276 | ALAN'S INDUSTRIAL SERVICES INC | Obion County | 731-264-9379 |
| SNL690000244 | PICKETT COUNTY LANDFILL | Pickett County | 931-846-3158 |
| SNL720000269 | RHEA COUNTY CLASS I LANDFILL | Rhea County | 423-775-7848 |
| SNL750000219 | BFI MIDDLE POINT LANDFILL | Rutherford Co. | 615-896-2075 |
| SNL760000271 | VOLUNTEER REGIONAL LANDFILL | Scott County | 423-569-5702 |
| SNL780000258 | SEVIER SOLID WASTE INC. | Sevier County | 865-453-5676 |
| SNL790000135 | BFI SOUTH SHELBY LANDFILL | Shelby County | 901-872-7200 |
| SNL790000224 | BFI NORTH SHELBY LANDFILL | Shelby County | 901-872-7200 |
| SNL800000227 | SMITH COUNTY LANDFILL | Smith County | 615-735-1941 |
| SNL900000262 | IRIS GLEN ENVIRONMENTAL CENTER | Washington Co. | 423-926-8375 |
| SNL930000136 | WHITE COUNTY LANDFILL | White County | 931-761-3358 |

*This list provided off of the following website: www.state.tn.us/environment/dor/pdf/TN_ClassI_Landfills.pdf

# Appendix C

## Total Reported Waste Generated

2005 Total Waste Generated TN & US

| 2005 Total Waste Generated in TN & US (tons/ year) | | | | | |
|---|---|---|---|---|---|
| County | Total Waste Generated | Total Organic Food+Yard+ Wood | Food Waste (11.9%) | Yard Waste (13.1%) | Wood Waste (5.7%) |
| Shelby | 2,517,411 | 772,845 | 299,572 | 329,781 | 143,492 |
| Davidson | 1,560,793 | 479,163 | 185,734 | 204,464 | 88,965 |
| Hamilton | 1,070,197 | 328,550 | 127,353 | 140,196 | 61,001 |
| Knox | 906,205 | 278,205 | 107,838 | 118,713 | 51,654 |
| Rutherford | 485,309 | 148,990 | 57,752 | 63,575 | 27,663 |
| Sullivan | 319,880 | 98,203 | 38,066 | 41,904 | 18,233 |
| Maury | 282,910 | 86,853 | 33,666 | 37,061 | 16,126 |
| Bradley | 254,154 | 78,025 | 30,244 | 33,294 | 14,487 |
| Williamson | 282,839 | 86,832 | 33,658 | 37,052 | 16,122 |
| Washington | 165,209 | 50,719 | 19,660 | 21,642 | 9,417 |
| **TOP 10** | **7,844,907** | **2,408,387** | **933,544** | **1,027,683** | **447,160** |
| **OTHER Counties of Interest** | | | | | |
| Montgomery | 227,903 | 69,966 | 27,120 | 29,855 | 12,990 |
| Madison | 1,073,781 | 329,651 | 127,780 | 140,665 | 61,206 |
| Sumner | 183,112 | 56,215 | 21,790 | 23,988 | 10,437 |
| Dyer | 123,159 | 37,810 | 14,656 | 16,134 | 7,020 |
| Cumberland | 67,017 | 20,574 | 7,975 | 8,779 | 3,820 |
| Warren | 75,874 | 23,293 | 9,029 | 9,939 | 4,325 |
| Sevier | 159,904 | 49,091 | 19,029 | 20,947 | 9,115 |
| Carroll | 35,056 | 10,762 | 4,172 | 4,592 | 1,998 |
| **TN** | **13,364,262** | **4,102,828** | **1,590,347** | **1,750,718** | **761,763** |
| **US** | **245,700,000** | **75,429,900** | **29,238,300** | **32,186,700** | **14,004,900** |

# Appendix D

## Total Generation, Disposal Per Capita, Diversion Per Capita

D.1 2005 Total Waste Generation & Diversion Per Capita

## 2005 Total Waste Generation & Diversion Per Capita (tons/year)

| County | Current Year Generation (Disposal + Reported Diversion) | 2005 Disposal | Current Year Population | Disposal Per Captia Ratio | 2005 Diversion | Diversion Per Captia Ratio | Total Waste Generated Per Captia Ratio |
|---|---|---|---|---|---|---|---|
| Shelby | 2,517,411 | 1,490,424 | 909,035 | 1.64 | 1,026,987 | 1.13 | 2.77 |
| Davidson | 1,560,793 | 839,779 | 575,261 | 1.46 | 721,014 | 1.25 | 2.71 |
| Hamilton | 1,070,197 | 471,687 | 310,935 | 1.52 | 598,510 | 1.92 | 3.44 |
| Knox | 906,205 | 470,510 | 404,972 | 1.16 | 435,695 | 1.07 | 2.24 |
| Rutherford | 485,309 | 269,898 | 218,292 | 1.24 | 215,411 | 0.98 | 2.22 |
| Sullivan | 319,880 | 191,394 | 152,716 | 1.25 | 128,486 | 0.84 | 2.09 |
| Maury | 282,910 | 178,388 | 76,292 | 2.34 | 104,522 | 1.37 | 3.71 |
| Bradley | 254,154 | 168,394 | 92,092 | 1.83 | 85,760 | 0.93 | 2.76 |
| Williamson | 282,839 | 151,681 | 153,595 | 0.99 | 131,158 | 0.85 | 1.84 |
| Washington | 165,209 | 139,954 | 112,507 | 1.24 | 25,255 | 0.22 | 1.47 |
| **TOP 10** | **7,844,907** | **4,372,109** | **3,005,697** | **1.45** | **3,472,798** | **1.16** | **2.61** |
| **OTHER Counties of Interest** | | | | | | | |
| Montgomery | 227,903 | 127,354 | 147,202 | 0.87 | 100,549 | 0.68 | 1.55 |
| Madison | 1,073,781 | 125,011 | 94,916 | 1.32 | 948,770 | 9.99 | 11.31 |
| Sumner | 183,112 | 77,842 | 145,009 | 0.54 | 105,270 | 0.73 | 1.26 |
| Dyer | 123,159 | 46,854 | 37,829 | 1.24 | 76,305 | 2 | 3.26 |
| Cumberland | 67,017 | 34,443 | 51,346 | 0.67 | 32,574 | 0.63 | 1.31 |
| Warren | 75,874 | 33,578 | 39,753 | 0.84 | 42,296 | 1.06 | 1.91 |
| Sevier | 159,904 | 32,061 | 79,282 | 0.4 | 127,843 | 1.61 | 2.02 |
| Carroll | 35,056 | 22,060 | 29,121 | 0.76 | 12,996 | 0.45 | 1.2 |
| **TN** | **13,364,262** | **6,685,136** | **5,962,959** | **1.12** | **6,679,126** | **1.12** | **2.24** |
| **US** | **245,700,000** | **133,300,000** | **296,410,000** | **0.45** | **112,400,000** | **0.38** | **0.83** |

# Appendix E

## Case Studies: Successful Composting and Recycling Programs

## E1. Recovery of Pre-Consumer Food and Floral Discards

Fletcher Allen Health Care, Burlington, Vermont

**90% Recovery Rate of Pre-Consumer Food Discards:**

The Medical Center Hospital of Vermont (MCHV) Campus of *Fletcher Allen Health Care* delivers approximately 90% of its food preparation scraps and steam table leftovers to an *off-site composting* facility. The hospital also donates produce to a food bank and sends grease to a rendering facility. Its food discard recovery program allows savings of approximately $1,400 per year in landfill hauling and tipping fees and to support a local farm.

Green Workplace Program Government of Ontario

**70% Recovery of Food Discards**

In 1991, the *Government of Ontario, Canada*, created the Green Workplace Program to facilitate waste reduction, resource conservation, and environmentally responsible purchasing in provincial facilities. An integral part of these waste reduction programs is composting which diverted 1,500 metric tons (1,650 U.S. tons) of food discards from landfills in FY96. From all composting programs combined *(in-vessel, on-site, and off-site)*, the Government of Ontario avoided C$150,000 in trash disposal costs. Of this avoided cost, C$8,580 was from its in-vessel program.

Larry's Markets, Seattle, Washington

**90% Recovery of Food and Floral Discards**

Larry's Markets recovers approximately 870 tons of organics annually through its *off-site composting and rendering*. Stores also donate canned goods to local charities. The *grocery chain* of five stores realizes a net savings of $40-$55 per ton of material recovered (about $41,000 per year). Larry's Markets has been very creative and persevered in overcoming problems in the initial phase of the food discards recovery program. Hauling heavy wet organics created weight limit problems for truckers before they could complete their pick up routes. Finally contracting with two additional companies to both haul the materials and run the composting sites. In closing the loop, Larry's Markets use the topsoil made from the composted food discards, yard trimmings, soil and other organics for landscaping.

## E2. Recovery of Food Discards

**Food Recovery and Food Rescue**

Food Recovery and Food Rescue programs in Tennessee are fairly well organized and efficient, saving millions of tons of organic waste from entering the landfill. **A waste audit or an organics waste characteristics study could possibly determine the source of organics landfilled in Tennessee.**

Food Banks and Food Rescue organizations fight hunger by collecting, sorting, and distributing over-stocked or short-dated foods that would otherwise be wasted. **America's Second Harvest,** a nationwide network of 211 food banks and 50,000 charitable agencies, distributes surplus food and grocery products to agencies serving approximately 26 million people each year. In 1995 Second Harvest distributed 811.3 million pounds of food to the hungry and prevented millions of pounds of food waste from entering the landfill. **Tennessee has six Second Harvest Food Banks** operating across the State: Second Harvest Food Bank of Middle Tennessee was selected the number one food bank in the country as *America's Second Harvest's 2003 Affiliate of the Year.* This organization distributed 14 million pounds of food during 2003/2004 fiscal year. Approximately 400,000 individuals were the beneficiaries of these food donations distributed through 450 partner agencies:

| | | |
|---|---|---|
| *Food pantries* | *Senior Citizens' Centers* | *Low Income Daycare Centers* |
| *Homeless Shelters* | *Group Homes* | *Emergency Food Box Program* |
| *Kids Café* | *"Take Home Food" for Kids* | *Summer Food Service Program (FSFP)* |

Sources of Food Contributions are numerous, with Tyson Foods pledging 10 million pounds of chicken protein to America's Second Harvest of which 63,000 pounds went to the Memphis Food Bank and Second Harvest of West Tennessee. Other contributors include:[i]

| | | |
|---|---|---|
| *Corporations* | *Food Manufacturers* | *Grocery Stores* |
| *Food Processors* | *Growers* | *Wholesalers* |
| *Distributors* | *Retailers* | *Religious Groups* |
| *Individuals* | | |

Food rescue organizations pick up excess prepared and perishable food from donors and then quickly re-distributes it to shelters, soup kitchens, and organizations and places in need. Three of Tennessee's Second Harvest affiliates are members of **Foodchain,** a national network consisting of 116 member programs and 22 associate programs in 39 states and the District of Columbia. Foodchain members are required to adhere to safe food handling standards. In 1995, Foodchain programs collected and distributed more than100 million pounds of food nationwide to 7,000 agencies. Tennessee members include:

| | | |
|---|---|---|
| *Knoxville Harvest* | *Nashville's Table* | *Round Up Memphis Food Bank* |

Nashville's Table (FC) merged with Second Harvest of Middle Tennessee in 2005 and has rescued more than 11 million pounds of food since its inception in 1989. This Foodchain member rescues food from over 300 donors including:

| | | |
|---|---|---|
| *Restaurants* | *Farmer's Market* | *Grocery stores* |
| *Hotels* | *Cafeterias* | *Universities* |
| *Schools* | *Bakeries* | *Caterers* |

Beneficiaries of Nashville's Table include:

| | | |
|---|---|---|
| *Soup Kitchens* | *Domestic Abuse Shelters* | *Low Income Childcare Centers* |
| *Rehabilitation Centers* | *Senior Citizen' Centers* | *Youth Programs* |
| *Homeless Shelters* | *Food Pantries* | *Emergency Food Recipients* |
| *Group Homes* | | |

As long as the food *has not* been put on a serving line and has been kept at the appropriate temperature in the refrigerator or freezer, the **Memphis Food Bank** will pick up the food. There are universally strict guidelines the trained drivers adhere to in testing temperatures for food safety. The drivers use their discretion when taking the food directly to places feeding the hungry. Occasionally in order to keep "customers" happy, drivers will take and discard unusable foods. The Memphis Food Bank does not compost its waste.

The Memphis Food Bank (FC) picks up food *daily* at:

| | | |
|---|---|---|
| *Memphis schools* | *Businesses* | *Hotels* |
| *Food stores* | *Restaurants* | *Special requests* |

## E3. Onsite Composting by Businesses and Institutions

**Onsite Composting by Businesses and Institutions**
Onsite composting will allow Tennessee to reduce the amount of garbage disposed in landfills. Across the U.S. businesses and institutions successfully compost waste food products. Below are case studies published by the EPA in recognition of award winners in its Waste Reduction Record-Setters Project. "Tips for Replication" are included by each stakeholder in these successful food recovery programs.

**Case Studies: *Don't Throw Away That Food: Summary EPA Case Study Fact Sheet***
Frost Valley YMCA, Claryville, New York

**100% Recovery of Discards**

Using a *static aerobic composting system*, this 6,000-acre *residential educational and recreational facility* in the Catskill Mountains composts 100% of the food discards from kitchen and dining room. From 1990, when Frost Valley began its comprehensive waste reduction program, to 1997, the facility reduced its total solid waste by 53% (by weight). Through food recovery, Frost Valley now realizes a net savings of $5,200 annually and provides a unique educational opportunity to thousands of visitors per year.

*Tips for Replication:* Make it easy for guests or participants to understand the program and its value. The educational classroom is an important component of composting at the facility.

Middlebury College, Middlebury, Vermont

**75% Recovery of Discards**

Students and employees collected approximately 288 tons of food discards for *on-campus composting* in 1996. This represented approximately 75% of the college's total food discards. As a result of its composting program, Middlebury avoids approximately $137 per ton in landfill hauling and tipping fees. In 1996, this led to a net savings of over $27,000.

*Tips for Replication:* Educate staff on how to compost. Keep an ongoing dialogue between the Environmental Coordinator and food service employees. Keep pushing through problems as they arise.

Tennessee Department of Correction

This state entity has a history of reducing costs through conserving resources. Brushy Mountain Correctional Complex in Morgan County composts, recycles, and reuses everything possible to reduce cost at its facility.

New York State Department of Correctional Services (DOCS), New York

**90% Recovery of Food Discards**

In 1997, 47 of 70 correctional facilities in the New York State *Department of Correctional Services of (DOCS) composted at 30 sites*, which accept from 1/2 to 4 tons

of food discards a day. Participating facilities recover 90% of their food and other organic discards. Through composting, DOCS facilities realize a net savings of $564,200 per year in avoided disposal costs. Tipping fees were approximately $125 per ton. Composting costs were approximately $34. In order to prevent odors, DOCS refrigerated waste until it could be taken out to the compost site.

*Tip for Replication:* Present a technically sound and feasible plan before starting to ensure success. Involve everyone at all levels from the start. Educate people so they understand why composting makes environmental and economic sense. If people understand why you are offering a program, they will buy into it.

## E. 4 Markets

**Markets for Food, Yard, and Wood Waste**

Recognizing and establishing markets is key to the success of any waste recovery program. It is particularly important to know the End Use of the waste in order that the quality meets the expectations of the customer. Unmarketable goods are the demise of the best managed waste recovery program. Prior to initiating a successful organics waste recovery program, one should read the *EPA's Decision-Makers Guide to Solid Waste Management, Volume II, 1995.*

**Compost and Mulch Markets**

To target the right markets, you must know the potential users of compost.

| | | |
|---|---|---|
| *Farms* | *Landscape contractors* | *Highway departments* |
| *Sports facilities* | *Parks* | *Golf courses* |
| *Office parks* | *Home builders* | *Cemeteries* |
| *Nurseries* | *Growers of greenhouse crops* | *Sod* |

Other Markets include:

*Manufacturers of topsoil (wholesale and retail distribution)*
*Surface mine reclamation (active and abandoned)*
*Silviculture (Christmas trees, reforested areas, timber stand improvement)*
*Agriculture (harvested cropland, pasture/grazing land, cover crops)*

**Food Waste Markets**

*Hog Farms*
*Animal Feed*
*Rendering*
*Fertilizers*
*Soil Amendments*

**Animal Feed-Tennessee Food Processors**

Numerous food processors in Tennessee avoid disposals costs and increase revenue by recycling their production waste into animal feed.

| County | Source of Waste | Feed (tons) | Recycler |
|---|---|---|---|
| ***Hamilton*** | | | |
| Brach's Confections | Bakery | 1,200 | Reconserve, Inc. |
| McKee Foods(Little Debbie) | Bakery | 10,602 | Reconserve, Inc. |
| ***Madison*** | | | |
| Sara Lee Foods | Bakery | --- | Hog Farmers |
| ***Dyer*** | | | |
| Sara Lee(Jimmy Dean) | Animal | 34,183 | Griffin Industries |
| ***Cumberland*** | | | |
| Flowers Bakery | Bakery | 4,164 | Reconserve, Inc. |

**Markets-Tennessee Organic Recyclables**
**Site Visits and Phone Interviews**

| County | Material Type | Market |
|---|---|---|
| ***Shelby*** | | |
| Memphis Earth Complex | Compost/Mulch | Nurseries, Public Giveaway, Government |
| Nature's Earth Products | Compost/Mulch | Public & Contractors |
| J & B Company | Mulch | Public & Contractors |
| Luttrell Corrections Facility | None | |
| ***Davidson*** | | |
| Davidson Co. Compost Facility | Compost/Mulch | Public & Boiler Fuel |
| The Mulch Stop | Mulch (Bulk) | Public & Contractors |
| The Mulch Company | Compost/Bedding Mix | John Deere Landscapes/Contractors |
| Alternative Energy | Mulch (Play Soft) | Playgounds, Handicap Facilities |
| ***Hamilton*** | | |
| John Deere Landscapes | Bedding Mix/Topsoil | Public & Contractors |
| James Recycling Center | Mulch | Public Giveaway, County Government |
| Brach's Confections | Food Compost | Pig Feed (ReConserve, Inc., Flowery Branch, GA) |
| McKee Foods(Little Debbie) | Food Compost | Pig Feed (ReConserve, Inc., Flowery Branch, GA) |
| ***Knox*** | | |
| Natural Resources Recovery | Compost/Mulch | Public,Nurseries, Garden Centers, Contractors |
| ***Williamson*** | | |
| John Deere Landscapes | Mulch/Bedding Mix | Public & Contractors |
| Mid-South Mulch Company | Mulch (Bulk) | Public & Contractors |
| The Mulch Company | Mulch/Bedding Mix | Public, Contractors, John Deere Landscapes |
| ***Madison*** | | |
| Sara Lee Bakery Group | Food Waste | Hog Farmers |
| ***Sumner*** | | |
| RASCO | Mulch | Contractor, Suspended Composting Program |
| ***Dyer*** | | |
| Sara Lee (Jimmy Dean) | Food Waste/Compost | Rendering(Griffin Industries),Com.In-House |
| ***Cumberland*** | | |
| Cumberland County Recycling | None | |
| Fairfield Community, Crossville | Compost | Use In-House |
| Flowers Bakery of Crossville | Food Compost | Hog Feed (Reconserve, Inc., Flowery Branch, GA) |
| ***Warren*** | | |
| Bouldin Corporation (WastAway Recycling) | Mixed MSW Soil Amendment | Nurseries, Contractors, Builders |
| ***Sevier*** | | |
| Sevier Solid Waste Inc. | Mixed MSW/Compost | Alternate Daily Cover, No Market, Surplus |
| ***Carroll*** | | |
| County Recycling Center | | |
| ***Tipton*** | | |
| ELS Slim Fast | Food Compost | Animal Feed |
| ***Morgan*** | | |

| | | |
|---|---|---|
| Brushy Mountain Correctional | Food Compost | Use In-House on Grounds and Operational Farm |
| ***Crockett*** | | |
| Pictsweet Frozen Foods, Inc. | Food Compost | Use In-House on Farms in Dyer, Lake & Obion Counties |
| ***Lake*** | | |
| Northwest TN Correctional | Food Compost | In-House on Farm, No Market; Surplus, Suspending 5 Year Program |

# Appendix F

Problems Associated with the Disposal of Organics

**Problems Associated with the Disposal of Organics in the Waste Stream**

***Food Recovery:*** One limitation of this strategy is that it can only be applied to pre-consumer food waste, and it must be stored in such a manner as to maintain freshness. State and local health code standards may further restrict donations of edible food. **To succeed, there must be some level of infrastructure to transport and store donations, and the collection methods must be convenient for food donors.** In addition identification of food agencies that could accept donations and generators receptive to food donation. Lastly, the identification and resolution of local health code regulations that might limit the donation of excess/leftover food.

***Grasscycling & Backyard Composting:*** This strategy generally only target residents of single-family dwellings (although some municipalities have also created backyard composting opportunities for residents of multi-family dwellings). This limits the number of households potentially participating. Animal products (e.g., meat, bones, dairy, grease); are excluded due to problems with odor and vermin. **Backyard composting takes time and effort, so this strategy requires interest and commitment from residents.**

***Municipal & Institutional Composting:*** **This approach can be labor intensive and is *most* successful when in structured environment and with ready supply of labor** (i.e. use of community service and/or prison labor). The necessity of space is another issue. Locations where any resulting odors will not cause problems should be chosen. Municipal composting of residential food wastes where the percentage of food waste was negligible compared to the other materials has seen some profitability, unfortunately this process is both labor intensive and costly. Composting of these mixed organics is complicated and expensive. Contamination rates are high and the resulting product literally with no marketability.

***Composting Odors***

Odor from composting can result from yard trimmings compost operations so proper site selection is of utmost importance. Grass is the primary contributor to odor problems, as its high moisture and nitrogen content can allow anaerobic conditions to occur. **Many programs find that promoting grasscycling in conjunction with yard trimmings collection helps reduce the amount of grass collected and prevents odor problems. Others include siting facilities away from residential areas and using certain technologies which capture process air and scrub it before release from the facility.**

***Pick up and Transport:*** Factors affecting program costs of yard trimmings composting include the collection method (e.g., curbside collection or drop-off), frequency of collection, materials targeted (e.g., leaves, grass, brush, or a combination), distance of composting facility from the source, quantity of yard trimmings collected, and the technology used for size reduction and turning compost windrows. Many trade-offs involved in determining the best options. For example, drop-off programs are much less expensive over all, but curbside collection programs divert approximately twice the amount of yard trimmings, and curbside programs generally have a lower cost per ton diverted. On site or composting close to the generation source is probably the least expensive alternative.

***Separation of Waste:*** Composting mixed organics is difficult and expensive. Due to high capital costs and operational costs, most mixed waste operations are not financially self-sufficient (EPA 1999). Contamination including that from non-compostable items (especially plastic bags) can be a challenge. Rates can be very high and reduces the marketability of the product. To offset this, some programs require residents to use paper or compostable plastic bags for collection of their Source Separation Organics programs. Businesses must have a system for keeping packaging waste separate from food residuals; requiring space for storage, and in some cases, refrigeration, of food prior to collection. There may also be laws regulating the types of food scraps that can be used as animal feed.

***Methane and other gases:*** Landfilling organics is problematic because it produces methane and other gases, collectively known as "landfill gas." This is not pure methane; it contains many other hydrocarbons (ethane, propane, benzene, toluene) as well as carbon dioxide, water, nitrogen, sulfur compounds, halogenated compounds, and even substances like mercury Some environmentalists argue that landfill gas collection systems capture relatively little of the landfill gas produced. Dealing with these gases continues to be costly in regard to air quality and the environment.

***Leachate:*** Equally problematic is the high moisture content of organics, which contributes to the formation of leachate. Add the various physical, biological, and chemical decomposition processes, which produce acids that dissolve substances out of wastes as the liquids filter through landfill contents, and the result is toxic liquids that collect and can ultimately leak into the surrounding soil. In the July 26, 1982 Federal Register, EPA stated its opinion that all landfills will eventually leak: "A liner is a barrier technology that prevents or greatly restricts migration of liquids into the ground. No liner, however, can keep all liquids out of the ground for all time. Eventually liners will degrade, tear, or crack and will allow liquids to migrate out of the unit." Working to stay ahead of this problem by decreasing organics being landfilled is the best way to deal with future problems. Tennesseans can 'pay now' to divert these materials or 'pay later' to deal with poor or hazardous groundwater quality.